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Technology and Aging in America

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Foreword

Rapid technological change in American society has been accompanied by accelerating growth of the population over 65. Older persons now outnumber teenagers in the United States; by 2025 the ratio will be more than 2 to 1 and the older population will have notably larger proportions in the oldest ages. New challenges will face the public and private sectors in both responding to the needs and utilizing the resources of older Americans.

This assessment was requested by the Senate Special Committee on Aging and the House Select Committee on Aging. A letter of endorsement was received from the House Committee on Education and Labor. The study focuses on the functional status of the elderly and ways in which technology can assist them to maintain their independence and enhance their quality of life. Recent significant improvements in longevity of the elderly have led to rising prevalence of chronic diseases that impair their ability to function independently.

The report discusses five chronic conditions that severely affect older persons—osteoarthritis, dementia, osteoporosis, hearing impairments, and urinary incontinence. The potential health improvements from behaviors that may delay the onset of chronic diseases, the need for increased biomedical research into the causes of these diseases, and methods to encourage behaviors that promote health are also reviewed. Special attention is given to the potential impact of telecommunications in the home and community in promoting self-health care among the elderly. The importance of medication for management of chronic impairments is also assessed, but much remains unknown about the particular effects of drugs on older persons. The report stresses the need for a coordinated approach to long-term care and improved technologies to assess health and functional status. A wider range of options for supportive services and settings would more appropriately respond to the different needs among the older population. Because Federal and State reimbursement policies influence the availability of health and long-term care services, changes in reimbursement criteria can promote such options.

The housing and living environment of the elderly are also described. Federal programs that subsidize rental housing for the elderly could pay greater attention to coordination of community-based services with these housing programs. New design standards that promote safety and improve the elderly's ability to be self-sufficient are also stressed. Modern construction technologies more easily allow existing single-family units to be renovated for the elderly. Shared housing, residential care facilities, accessory units, and other types of residences would expand the housing choices available to older Americans. The study also evaluates the impact of changes in workplace technology. Job security may be weakened in some industries, while in others it can enhance job performance, safety, and security for older workers. Telecommunications are making the "electronic cottage" a reality and older persons may be able to take advantage of emerging opportunities for home-based work arrangements. Finally, the retraining of older workers would encourage continued employment or provide new employment possibilities.

OTA was assisted in the preparation of this study by an advisory panel of individuals representing a wide range of backgrounds, including geriatrics, health policy, biology, gerontology, demography, economics, academia, private industry, labor, and advocacy organizations. More than 80 reviewers drawn from universities, governmental agencies, and the private sector provided helpful comments on draft reports.

OTA expresses sincere appreciation to each of these individuals. As with all OTA reports, the content is the responsibility of the Office and does not necessarily constitute the consensus or endorsement of the advisory panel or the Technology Assessment Board.

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NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory panel members. The views expressed in this OTA report, however, are the sole responsibility of the Office of Technology Assessment.

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Related Activities and Products

"The Impact of Technology on Long-Term Care," a workshop jointly sponsored by OTA, Project HOPE, and the National Health Policy Forum (held February 1983)
Impacts of Neuroscience, OTA Background Paper
Management of Hearing Impairment in the Elderly, OTA Background Paper
Technologies for Managing Urinary Incontinence, OTA Case Study

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Contents

Chapter *Page*

1. Executive Summary 3
2. Introduction: Technological Change and the Older U.S. Population 33
3. Selected Chronic Conditions, Technology, and Biomedical Research 61
4. Health Promotion/Disease Prevention and Nutrition in the Elderly 119
5. Medications and the Elderly 137
6. Information Technology and the Health of an Aging Population 159
7. Technologies, Functional Impairment, and Long-Term Care 185
8. Health Care Costs and Access to Technology for Older Persons 249
9. Technology, Housing, and the Living Environment of the Elderly 277
10. Workplace Technology and the Employment of Older Adults 335

Appendixes

A. Morbidity and Mortality Data 369
B. The Cell Biology of Aging 413
C. Nutrition Information 421
D. Biotechnology 447
E. Workplace Technology and the Employment of Older Adults 458
F. Glossary of Terms and Acronyms for Technology and Aging in America . . . 479
G. List of Contractors 485

Index 489

Chapter 1

Executive Summary

Contents

Page

Introduction 3
Definitions and Focus 7
Changes in Health Status 7
  Population Aging and Changes in Selected Chronic Conditions 7
  Health Promotion/Disease Prevention and Nutrition 10
  Medications and the Elderly 13
Changes in Health Services 15
  Information Technology and Health Care of the Elderly 15
  Functional Impairment and Long-Term Care 18
  Health Care Costs 21
Social Changes in the Living Environment 23
  Housing and the Living Environment 23
Work-Related Changes 27
  Workplace Technology and the Employment of Older Adults 27
Conclusion 30

Figures

Figure No. *Page*

1. Number of Teenagers and Older Persons, United States, 1970-2050 3
2. Fertility Rates per 1,000 Women Aged 15 to 44 Years, United States, 1930-82 5
3. Infant and Neonatal Mortality Rates, United States, 1930-82 5
4. Crude and Age-Adjusted Death Rates, United States, 1930-82 6

Chapter 1

Executive Summary

Introduction

This century is witnessing unprecedented demographic and technological changes in American society. There have been significant gains in life expectancy, both at birth and at the older ages. Declining fertility rates have "aged" the U.S. population, and there have been major improvements in health status.

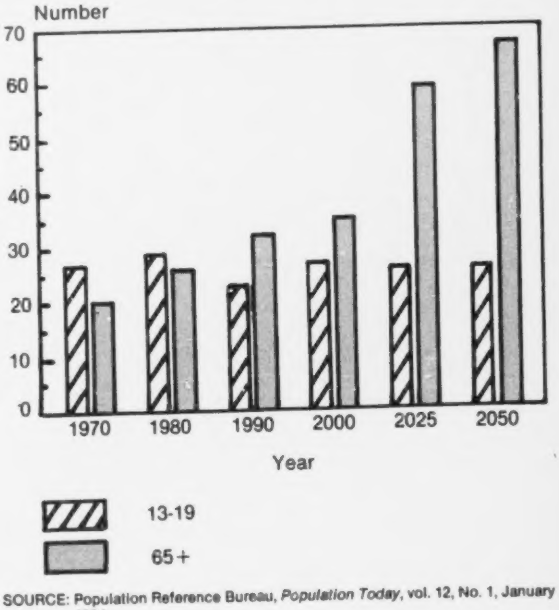
By 1980, for the first time in the history of the United States, 50 percent of all Americans were over 30. Today there are more persons over 65 than there are teenagers. The elderly population[1] has grown from 4.0 percent of the total in 1900 to more than 11.5 percent in 1983. The number of those over 65 is projected to grow from today's 27 million to an estimated 39.3 million by 2010, when they will constitute almost 14 percent of the Nation's population.

More significantly, between 2010 and 2020 the older population is expected to increase by more than 12 million, when the first wave of the baby boom cohort becomes the elderly boom of the future. By 2025 there will be more than twice as many older Americans as teenagers (see fig. 1). These demographic trends are due in large part to technological[2] changes since 1900—changes whose pace is accelerating. This technological revolution has major implications for all aspects of society.

During this century, improved technologies have increased life expectancy at birth from an average of 47 years in 1900 to more than 74 years in 1982. These technological improvements include advances in public hygiene and sanitation, reductions in the prevalence of infectious diseases through immunization and antibiotics, and the continued improvement and accessibility of general health care to all persons. The effects of these advances have been most noticeable at the earliest ages, where dramatic improvements have increased the probability of surviving beyond the first year of life. **Almost four-fifths of all babies born this year can expect to live to age 65; only two-fifths of babies born in 1900 could expect to do so.**

More recent technological advances have helped reduce mortality rates at the older ages. During the past 15 years, sharp reductions in death rates from two major killers—heart disease

Figure 1.—Number of Teenagers (Aged 13 to 19) and Older Persons (Aged 65 and Over), United States, 1970-2050 (number in millions)



SOURCE: Population Reference Bureau, *Population Today*, vol. 12, No. 1, January 1984.

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[1] For purposes of this assessment, the elderly population is generally defined as all persons aged 65 and over, although in designated cases the age identifier can be as low as 40 years or as high as 85 years (the very old).

[2] "Technology" is broadly defined here to include the development of knowledge and its application to solving practical tasks and problems; it also refers to such factors as biomedical research into the causes of arthritic conditions, as well as wheelchairs used by persons suffering from severe arthritis. Technology can be "soft" (research and knowledge) or "hard" (products of research), and "high" (complex) or "low" (simple).

and stroke—have caused mortality rates among the elderly to plummet. Death rates fell more sharply during this period than during any 15-year period in U.S. history. **More than half of the improvement in life expectancy for the elderly since 1950 has occurred in the past decade.** Recent age-specific mortality rates indicate that this accelerating pace of improvement in life expectancy at older ages will continue for the foreseeable future. The most dramatic changes are the increases in the proportions of people surviving to the oldest ages (i.e., 75 or 85 years). Other technologies may lead to changes in the aging of cells that could have consequences for the human life span,[3] as discussed in chapter 2.

The "newness" and swift pace of these gains in life expectancy at older ages signify a new era in the changing demographic structure of the United States that has important consequences for all aspects of society. This era is also characterized by rapid technological advances in the ability to plan fertility[4] (e.g., oral contraceptives, intrauterine devices), enabling individuals to more closely realize their childbearing preferences. The post-World War II baby boom was abruptly succeeded by the "baby bust" of the last decade. Fertility has been as important a factor as mortality in determining the changing age structure of the Nation's population. Among the significant and unprecedented demographic changes of recent decades are:

- dramatically lower fertility rates among women of childbearing age, a trend that began in the late 1950s and recently stabilized at a rate below replacement level (see fig. 2);
- similarly dramatic reductions in infant and neonatal mortality rates[5] over more than half a century that are approaching an expected minimum possible level (see fig. 3); and
- sharp declines in the age-adjusted death rates[6] of the total population since 1930 (see fig. 4).

In combination, these demographic trends have produced an aging population that is characterized by accelerating increases in life expectancy at the oldest ages. Moreover, the gains in life expectancy at birth and at older ages have consistently been greater for females than males; there are now 5 million more older women than older men in the United States.

The effect of technology on population structure is expected to continue. For example, the median age, which rose only 0.6 years between 1960 and 1980, is expected to rise by 3.3 years between 1980 and 2000. That this significant demographic shift will occur during such a short interval underscores the increasing pace of population aging in the United States. Potential consequences include changes in the structure of families, more older persons living alone (four-fifths of them women), more older workers, and a growing market for services and products to the elderly. In general, this profound demographic transformation is likely to change both the resources older persons have to offer and the allocation of resources offered to them.

These changes may occur even faster than is currently anticipated. **Previous demographic projections have underestimated the rate of change in population aging, due in part to difficulties in anticipating the development of new technologies and their short- and long-term effects on fertility and mortality.**[7] The phenome-

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[3] "Life span" is the biological upper age limit that a human can potentially reach, currently considered to be about 120 years.

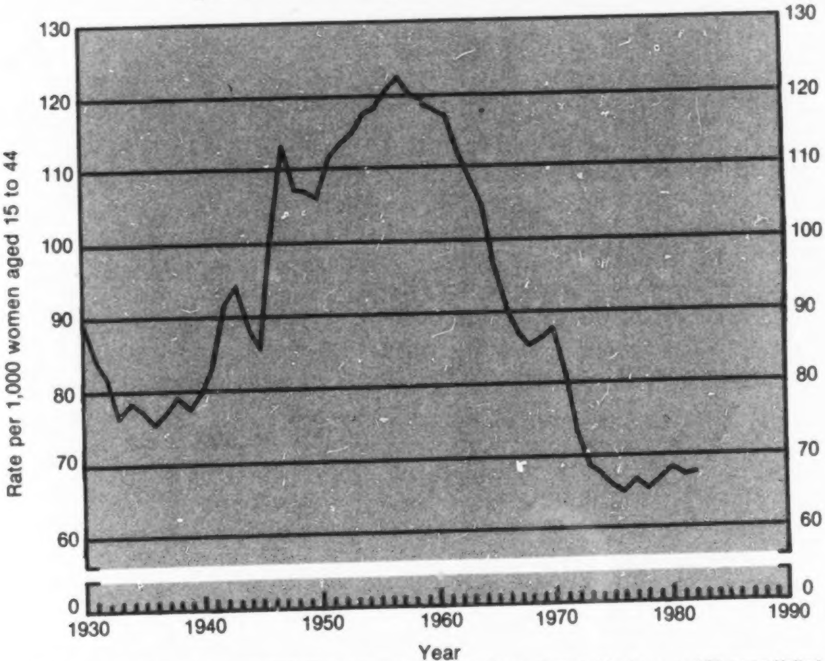
[4] "Fertility" is a measure of the number of live births within a population, such as "number of births per 1,000 women aged 15-44". Fertility measures do *not* account for stillbirths and aborted pregnancies, whether induced or spontaneous.

[5] The current U.S. infant mortality rate of 10.9 (deaths to infants under 1 year of age per 1,000 live births) ranks 14th in the world. The lowest rates are 6.5 in Finland and 6.8 in Sweden, while many developing countries have rates well above 100 (e.g., 134 in Nigeria and 153 in Liberia). Thus, the *relative* possible improvement in the U.S. infant mortality rate is very small when compared with rates in most other countries.

[6] In contrast to "crude rates," "age-adjusted" rates control for the effects of age-structure differences in a population over a period of time. Analogous to the use of "constant dollars" in economic analyses, they are the best indicators of actual change in demographic rates over time.

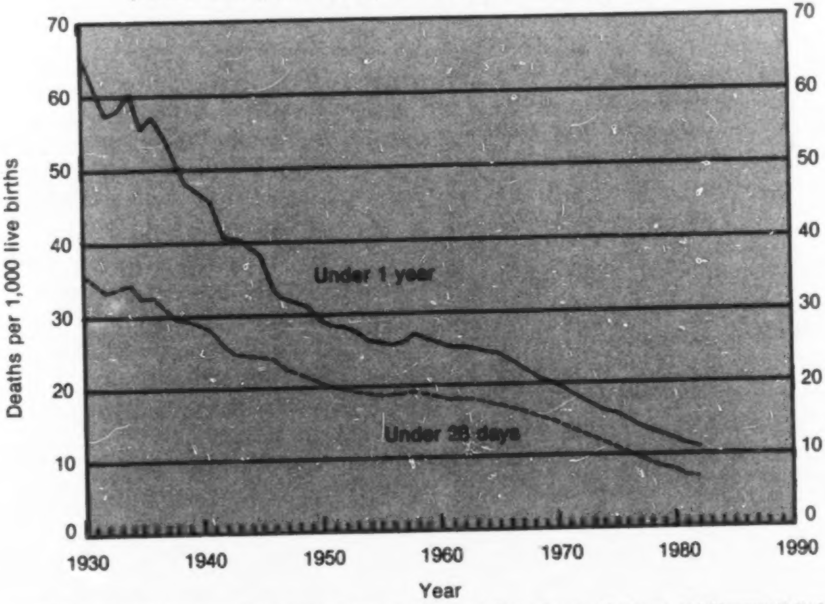
[7] The Bureau of the Census projections for the older population have consistently underestimated the number of older persons in future decades. For example, in 1977 the bureau attempted to account for changing mortality rates among the elderly by increasing its 1975 projections of the older population for 2000 from 28.8 million to 31.9 million. The latest revisions are for almost 34.1 million elderly in 2000. In less than a decade the projections of this population have been increased by 18 percent in response to the most recent effects of technological advances in health and medical care.

Figure 2.—Fertility Rates per 1,000 Women Aged 15 to 44 Years, United States, 1930-82



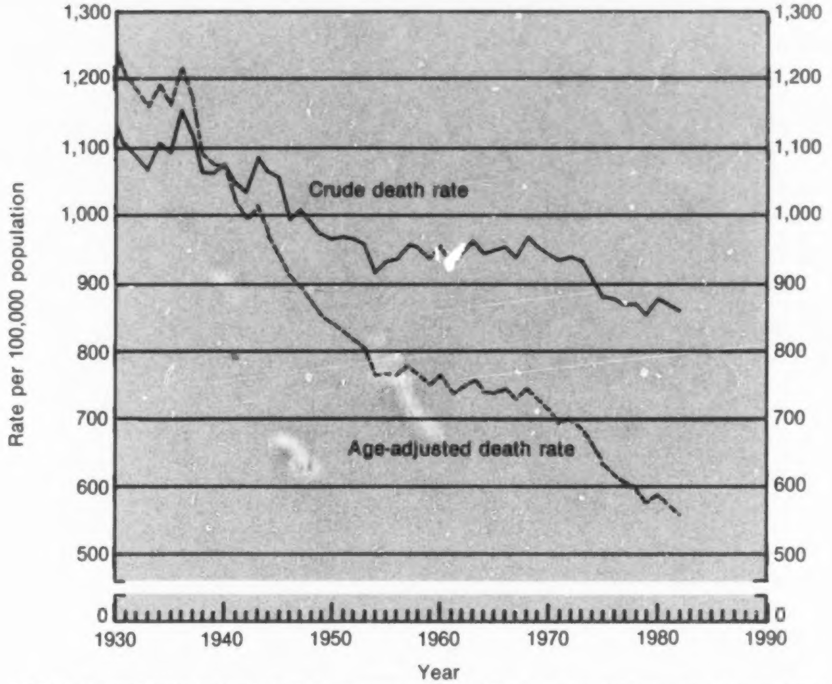
SOURCE: National Center for Health Statistics, "Annual Summary of Births, Deaths, Marriages, and Divorces: United States, 1982," *Monthly Vital Statistics Report*, vol. 31, no. 13, DHHS publication No. (PHS)83-1120 (Hyattsville, MD: Public Health Service, October 1983).

Figure 3.—Infant (Under 1 Year) and Neonatal (Under 28 Days) Mortality Rates, United States, 1930-82



SOURCE: National Center for Health Statistics, "Annual Summary of Births, Deaths, Marriages, and Divorces: United States, 1982," *Monthly Vital Statistics Report*, vol. 31, no. 13, DHHS publication No. (PHS)83-1120 (Hyattsville, MD: Public Health Service, October 1983).

Figure 4.—Crude and Age-Adjusted Death Rates, United States, 1930-82



SOURCE: National Center for Health Statistics, "Annual Summary of Births, Deaths, Marriages, and Divorces: United States, 1982," *Monthly Vital Statistics Report*, vol. 31, no. 13, DHHS publication No. (PHS)83-1120 (Hyattsville, MD: Public Health Service, October 1983).

nal pace of current changes is readily apparent in other areas of technology. For example, a microprocessor measuring less than 3 inches on a side now has the capability of a computer that 20 years ago was the size of an average business office. The rate of increase in storage capacity of computer memory chips has been exponential, rising from the 1-bit chip in 1970 to today's current chip with more than 250,000 bits; recent development of an experimental 1-million-bit chip indicates that its commercial mass production is only a few years away. Dramatic technological changes such as these have future consequences that can only be partly envisioned. Similarly, although the societal effects of technological change and the aging of the population are only partly foreseeable, they are likely to be felt in various ways:

- *Changes in health status*. The prevalence of chronic illnesses and attendant functional impairments among the elderly will rise as the proportions of those in the oldest subgroups increase.
- *Changes in health services*. The need for social and health care services (i.e., long-term care) for chronic conditions will grow, as will the demand for medical care for treatment of acute illnesses.
- *Social changes in the living environment*. Significant changes are expected in family structure, living arrangements, and the housing environment of the elderly; more older persons will live alone, and people over 55 will be more likely to have a very old parent still alive.
- *Work-related changes*. Older workers may be particularly vulnerable to the impact of new methods of production and workplace technologies, and to changes in the skills required of the labor force.

This assessment describes the reciprocal relationship between technology and aging in America by focusing on these four general topics. Changes in these areas are interdependent and offer both broad challenges and striking opportunities to society. The balance of this chapter summarizes the major components of this study and highlights its major findings. Selected issues arising from each area are presented for congressional consideration. Full development of the issues and possible congressional options are contained in chapters 3 through 10.

Definitions and focus

In keeping with congressional requests and the advice of the Technology and Aging Advisory Panel, the term technology is broadly defined in this assessment. It is viewed as both a collection of devices or gadgets (i.e., hard technology) and the development of knowledge or an organizational system (i.e., soft technology). The two types of technology form the ends of a continuum. Within the continuum, the most relevant types of technology have been selected for each of the substantive areas. Knowledge and research are thus stressed in some instances, and hardware and devices in others.

Another dimension of technology is its degree of complexity, which can range from simple "low-technology" devices such as stair safety treads to complex "high-technology" equipment such as the computerized axial tomography (CAT) scan used for medical diagnosis. The range of technological complexity and types leads to different approaches and findings for each major subject of this assessment, which accordingly covers a variety of issues and options for congressional consideration.

A general theme, however, prevails throughout. **The most important variable in this assessment of the relationship between technology and aging is the physical and mental functioning of older persons. Most people do not fear "growing old" so much as they fear becoming chronically ill or frail. The "vitality" of older people—their ability to remain functionally independent, or to be minimally dependent on various types of assistance—is the fundamental characteristic that determines their quality of life at home, in the workplace, and within the community. The extent to which various technologies can improve the ability of older persons to maintain this vitality is a major focus of this report.**

Changes in health status

*Population aging and changes in selected chronic conditions**

The second half of the 20th century has seen a dramatic shift in the types of diseases afflicting people, especially in technologically advanced countries. The incidence of many infectious diseases has fallen sharply as sanitation has improved and vaccines have been developed; many of the remaining infectious diseases can be effectively treated with antibiotics. Death rates from diseases of the heart and blood vessels have also begun to change as a result of diet, personal habits, and improved health care. If these trends continue, several predictions can be made:

- life expectancy at older ages will continue to rise, as will the median age of the population;
- diseases whose incidence rises with age will become more prevalent;
- environmental, behavioral, and dietary factors affecting health may become more important because individuals will live through longer periods of exposure and have more time to develop symptoms; and

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*These issues are examined in detail in chs. 2 and 3 and app. A.

- new and unexpected medical problems may appear.

As death rates from vascular diseases decline, the prevalence of other chronic health conditions such as dementia, arthritis, cancer, deafness, poor vision, and other currently incurable and unpreventable ailments is likely to increase. **The progression from infectious to cardiovascular to other chronic conditions has followed the path of clinical ignorance; the disorders that are now most common are those about which the least is known.** Far more is understood about the cause of tuberculosis (now rare) than about the causes of Alzheimer disease[a] (the most common disorder causing dementia among the elderly).

There are four general strategies for dealing with chronic health conditions:

- treatment of acute episodes of illness arising from underlying chronic illness;
- long-term medical treatment or long-term care;
- prevention; or
- research to improve diagnosis, treatment, and prevention.

Each of these strategies is influenced by Federal policy; a balanced approach is required for effective control of chronic disease. Current Federal policy tends to favor acute care over preventive strategies, long-term care, or research. In surveying the conditions that most affect the elderly population of the United States, OTA, with the assistance of the Technology and Aging Advisory Panel, chose five conditions as especially worthy of review, using the following seven criteria:

- the condition is an important cause of death and disability among the elderly population due to severity or prevalence;
- the condition is chronic and persistent among the elderly;
- the impact on caregivers, including family members and friends, is a significant hardship;
- the condition contributes to functional impairment and the demand for long-term care, a major focus of this assessment;
- easily readable and up-to-date summaries of the state of science and medicine regarding the condition are not readily available;
- technology is relevant to correction of or compensation for the condition; and
- Congress has recently demonstrated a special interest in the condition.

The five chronic conditions reviewed are **dementia, urinary incontinence, hearing impairment, osteoporosis, and osteoarthritis.**

Dementia was selected because Alzheimer disease and other dementing illnesses will become overwhelming health problems unless means for prevention or treatment are found. These diseases are severe, affect an important aspect of human function—mental ability—and are the most common determinants of need for long-term care. There are as yet no reliable or specific means of accurately diagnosing dementing disorders, although improvements have been rapid in recent years. Further, these disorders are probably not single entities, but combinations of related but biologically distinct diseases that have not yet been scientifically differentiated.

The main policy options relating to Alzheimer disease and dementia thus concern long-term care for demented patients and biomedical research. Although the ultimate solutions to dementing illness must come from research, they are not likely to be achieved in the short term, despite recent advances in knowledge of these conditions; the problem of caring for demented patients for the final years of their lives will be very great for a number of years to come. The social and economic value of successful research in this area is enormous.

Urinary incontinence is a growing problem among the elderly, and is another major reason for institutionalization. It is a common symptom of different neurological, endocrine, vascular, and urological diseases that can now be treated with technologies ranging from absorbent pads to sophisticated mechanical devices and surgery. Difficulty persists in diagnosing the condition among the noninstitutionalized elderly, who often do not seek medical attention or do not admit to what can be an embarrassing problem. Because many of the relevant technologies are just coming to fruition, incontinence should be far more effectively treated or managed in the future.[9]

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[a] This assessment uses the term "Alzheimer disease" (instead of the more familiar "Alzheimer's disease") in accord with recommended usage by the American Academy of Neurology and the American Neurological Association and their respective journals.

Discussion of the problem of incontinence and potential policy issues centers on the substantial delay in developing appropriate technologies, as well as possible drawbacks of present technologies. Improvements in this area could notably reduce the nursing home population and permit families to directly care for their incontinent dependents for a longer period of time. Equally important would be the great improvement in the quality of patients' lives.

Hearing impairments affect almost 30 percent of all older Americans; 23 percent of those aged 65 to 74 and almost 40 percent of those over 75 suffer some hearing loss. Most hearing impairments of the elderly cannot be corrected with available medical or surgical techniques, but technologies such as hearing aids and assistive listening devices can compensate for some forms of hearing loss. But the adaptation of appropriate technology to specific hearing defects of patients, especially elderly patients, has had limited success. The potential for improvement of hearing is substantial if diagnosis is made early enough, if patients can be convinced of the value of correction, and if industry can adapt to better serving patients' needs.[10] Technological innovation in this area promises to be rapid over the next decade.

Federal policy issues include assurance of patient safety in public places (e.g., mandating alarms that can warn those with hearing impairments of danger), reimbursement policy for Medicare and Medicaid (which currently offer little support for those with hearing impairments), increased regulation of the hearing-devices industry, and sponsorship of training and research.

Osteoarthritis, which affects 16 million to 20 million older Americans, is the largest single cause of disability among the elderly. Radiologic evidence of osteoarthritis is found in over four-fifths of persons over 70. Technological issues related to osteoarthritis include a relative lack of basic scientific knowledge about the biology of cartilage, a need for preventive strategies, the potential for reducing pain and suffering for a large proportion of patients, and the enormous expense of current therapies, particularly joint replacement surgery. Like dementia, osteoarthritis is in need of expanded research that could lead to discoveries for effective prevention and cure.

Osteoporosis is a disease process involving thinning of bones. Its most devastating consequences are fractures of the vertebrae and long bones, which are especially common in elderly women. Fractures of the hip often result in death or extended periods of rehabilitation, chronic impairment, or nursing care. Current evidence suggests that osteoporotic fractures are amenable to prevention by such methods as increasing calcium intake and postmenopausal administration of estrogens, but a definitive preventive protocol has not been established because the various regimens used in routine practice have not yet been rigorously compared.

SELECTED ISSUES*

Effective treatment or prevention of these five chronic disorders is needed, and adaptation of technology to compensate for the ravages of chronic disabilities will be increasingly in demand in future years. For conditions that can be ameliorated by existing technologies, such as some types of hearing impairments and incontinence, the availability, application, and improvement of such technologies is a priority. Other policy considerations include possible oversight to promote increased awareness and sensitivity to the extent of chronic illnesses among the elderly and the possibilities for their management.

Research on chronic diseases, however, provides the only possibility for their ultimate elimination. For this reason, two general issues merit congressional attention:

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[9] This subject if more fully discussed in the forthcoming OTA case study on "Technologies for Managing Urinary Incontinence" (January 1985).

[10] For a detailed review, see the forthcoming OTA background paper on "Management of Hearing Impairment in the Elderly" (January 1985).

*For brevity, only the most important issues for congressional consideration are presented in this chapter. These and other issues, each with a number of options, are discussed in greater detail in their respective chapters. See ch. 3 for further discussion of the issues in this section.

- *Should Congress increase support for basic and clinical biomedical research and for longitudinal studies on aging and chronic diseases?*
- *Should Congress exercise more or less control over the extent, direction, and selection of problem areas of basic biomedical research related to aging?*

Health promotion/disease prevention and nutrition*

An increasing body of evidence demonstrates that preventive measures begun early and maintained throughout life can significantly reduce the prevalence of acute and/or chronic disease in old age. Preventive measures are considered here in the context of persons over 65, while recognizing the importance of preventive measures throughout life.

Until recently there was consensus among health professionals, and among the elderly themselves, that after 65 it was too late to think seriously about prevention of disease or disability. These attitudes are slowly changing, and health promotion is now justified on the basis of rising life expectancy *after age 65* (on average, currently more than 14 years for men and 18 years for women), more sophisticated definitions of health that recognize variability among and between age groups, and recent improvement in cardiovascular disease mortality due to preventive efforts (e.g., control of hypertension and elimination of smoking).

The goals of health promotion/disease prevention vary with personal circumstances. For those who are ill, the hope is to maximize function and prevent deterioration; the goal of those who are well is to prevent disease or disability at any age.

MORBIDITY, MORTALITY, AND RISK FACTORS RELATED TO CHRONIC DISEASES

Diseases of the heart, malignant neoplasms (cancer), and cerebrovascular disease (stroke) accounted for three-fourths of all deaths among the elderly in 1981. The incidence of these major diseases remains high, but death rates from most have decreased for the elderly. As more older persons survive acute episodes of stroke and coronary heart disease, the prevalence of these diseases rises. Because the burden of morbidity in the older population is rising, this assessment examines the risk factors[11] that are correlated with these diseases and chronic conditions.

CORONARY HEART DISEASE AND STROKE

A cluster of risk factors correlates both with coronary heart disease (CHD) and stroke. **Hypertension,** or high blood pressure, is the most powerful predictor of risk for CHD; more than half of persons with myocardial infarction and three-fourths of patients with stroke have concurrent hypertension.[12] Limited findings indicate that control of moderate and high diastolic hypertension in older individuals is associated with reduced mortality and morbidity from CHD and stroke, but the benefits of treatment of isolated systolic hypertension remain unclear and are under investigation.

Cigarette **smoking** is highly correlated with mortality from cardiovascular disease; it is also a significant factor in morbidity, exacerbating hypertension (nicotine constricts the blood vessels). Hypertension, in turn, is another risk factor for CHD and stroke. Unfortunately, the elderly often succumb to the myth that smoking cessation is effective only for younger age groups. Now that those who reach 65 can expect to live an average of 16 more years, the benefits of not smoking are substantial. Programs and research on smoking cessation should be expanded to give greater emphasis to their impact on older individuals.

Despite gaps in knowledge, it appears that **exercise** can benefit the elderly in reducing their risk of CHD and stroke. Some gerontological studies indicate that carefully developed exercise regimens for older people can reduce blood pressure and pulse rate at rest while also increasing

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*These issues are examined in detail in ch. 4 and app. C.

[11] Risk factors are characteristics that indicate an increased likelihood of developing a given condition. They are based on statistical probabilities in large populations rather than on causal relationships or the certainty that an individual will develop a specific disease or condition.

[12] Hypertension in the elderly is defined as blood pressure greater than 140/90mm Hg or isolated systolic blood pressure greater than 160, with normal diastolic blood pressure.

Photo credit: Dennis Deloria, Dancers of the Third Age, Dance Exchange, Washington, DC

Properly developed exercise programs can benefit one's health at any age.

aerobic capacity. Exercise reduces fat and increases lean body mass, and can promote healthy bone. Yet exercise carries certain risks and, especially for the elderly, should be gradually initiated according to individual health characteristics. The risks depend on a number of factors—general health, past exercise habits, age, type and amount of exercise, and intensity of exercise. Nevertheless, when weighed against the hazards of not exercising, the benefits clearly outweigh any risks. More information needs to be developed regarding the relative risks and benefits of different levels of exercise for older persons, particularly those suffering from chronic conditions.

Although **stress** is a normal part of life, little documentation exists regarding the prevalence, types, and effects of stress on older persons. A possible indicator of stress is the prevalence of depression, the most common mental problem among older people. Depression is one symptom of the inability to cope with stress, which can cause various types of health impairment. Stress-reduction techniques—such as exercise, meditation, and relaxation—can reduce the physical and psychological effects of stress. Biofeedback techniques can also help minimize the negative consequences of stress. In severe cases, prescription drugs are also effective treatments.

As with exercise, a considerable body of knowledge remains to be developed regarding the specific characteristics of stress and its consequences for the elderly.

Nutrition, including intake of liquids, appears to have special significance for older persons. Poor nutrition results in a lack of essential vitamins and nutrients, which leads to physiological deficiencies. Poor nutrition can also be manifested in an excess of certain nutrients that are related to obesity,[13] to higher risk of diabetes, and to higher levels of cholesterol—all of which are risk factors for CHD and stroke. Insufficient intake of liquids can lead to dehydration, which is often undetected for long periods. Among the elderly, changes in metabolism and physical activity can significantly alter the intake, absorption, and effective utilization of various nutrients. There is as yet too little information, however, on which to base Recommended Dietary Allowances (RDAs) specifically for the elderly population. It is particularly difficult to discern the long-term subclinical deficiencies that may be related to the aging process.

Current Federal policy, as implemented under the Older Americans Act, is designed to improve the nutritional status of the older population through the congregate meals and meals-on-wheels programs. Existing evaluations of these programs are methodologically flawed and provide insufficient information about the programs' effectiveness in reaching the at-risk poor and minority elderly. Future evaluations should also focus on the nutritional value of the food actually consumed rather than on just the food that is prepared.

Impaired **glucose tolerance** is symptomatic of diabetes mellitus, which is in turn a risk factor for cardiovascular disease. Moreover, diabetes is strongly associated with obesity, especially as age increases. Drug therapy can reduce glucose levels and promote management of diabetes, but its efficacy in CHD prevention is unclear. Dietary restrictions are also used in management of CHD, but little is known about possible ways to prevent or minimize its incidence.

High serum cholesterol levels, which are related to diets high in saturated fats, have recently been linked with atherosclerotic diseases of the blood vessels. A study of men aged 35 to 59 with very high levels of cholesterol who were given drug therapy to reduce those levels found a significantly lowered incidence of CHD. However, no direct causal effect can be inferred concerning the effect of reduced *dietary* levels of saturated fats for those with moderately elevated cholesterol levels, since the research involved men with high levels of cholesterol who were treated with drugs. More clinical and longitudinal investigations are required to clearly understand the relationship between diet and moderately high levels of cholesterol in the older population.

CANCER

Cancer, the second leading cause of death among the elderly, is associated with risk factors such as smoking and diet, although it remains difficult to establish specific causal links from available analyses. If detected early enough, cancers of the prostate, breast, lung, rectum, and colon can be effectively treated. Regular medical checkups and self-examination are very important factors in early detection of cancer. Unfortunately, some studies indicate a reluctance among the elderly to seek screening services, particularly gynecological examinations for older women. This may be due to ignorance or lack of information about new technologies and the possibilities for treatment of many diseases, including some cancers. Careful monitoring of changes in the body is important, because multiple presentations of illness in the elderly can mask the existence of some diseases and make early detection difficult.

FRACTURES

Osteoporosis is the cause of about two-thirds of hip fractures in older people, especially women. Research to prevent osteoporosis is centered on the effectiveness and possible risks of estrogen replacement therapy after menopause, supplemental doses of calcium for women both before and after menopause, and the role of exercise in bone-strengthening. Up to 40 percent of the elderly report suffering a fall. Two-thirds of these are estimated to be preventable, and as many as half may be caused by environmental factors such as loose rugs, poor lighting, slippery surfaces inside and outside the home, broken stairs, or lack of grab-bars in bathrooms and other high-risk areas. The likelihood of falls is increased by underlying physical conditions such as Parkinson's disease, seizures, cerebrovascular disease, and conditions that cause fainting or dizziness (including inappropriate use of drugs). Sensory loss in hearing and vision also increase the risk of falls.

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[13] Obesity is generally defined as weight that is 20 percent higher than specified in standardized tables according to sex, age, and height. Obesity itself is associated with numerous risk factors for CHD and stroke.

The incidence of falls and the severity of their consequences for the elderly could be reduced by better diagnosis and treatment of these chronic conditions and efforts to eliminate environmental hazards. Concerted efforts are required to sensitize the general public and the elderly themselves to the possibilities for greatly reducing the risk of falls, and the suffering and expense they can cause.

DENTAL DISEASE

An often overlooked problem for the elderly is dental disease. In 1971, about 45 percent of Americans over 65 were estimated to have lost all of their teeth. Loss of teeth is associated with poor dental hygiene, a diet high in starches and simple sugars, and lack of regular dental care. Dental diseases, including those of the gums and bone, can have significant consequences for the general health of the elderly. Yet in 1981 approximately half of all older persons who had teeth had not visited a dentist in the previous 5 years.

Improved monitoring of dental health for the elderly and the application of new technologies for prevention and treatment of dental disease should be fostered. Medicare reimbursement is not provided for any preventive dental services, which may be a reason for the extent of inadequate dental care among the elderly.

SELECTED ISSUES

Each of these areas of health promotion/disease prevention and nutrition requires additional information and research regarding their long-term effects on the well-being of older persons. Understanding the interaction of individual health behaviors and environmental influences for promoting health into the older ages may provide new suggestions for preventing, coping with, or at least delaying the onset of chronic diseases. A substantial research effort over an extended period of time is needed to achieve this definitive knowledge.

Most current RDAs do not differentiate between subgroups over age 50. The same RDA is supplied for all ages past 50, regardless of nutritional need. In general, RDAs fail to take into account the age-related physiological, behavioral, and pathological changes that can affect the nutritional needs of those over 65. Certain nutrients are especially relevant to the aging process and should be stressed in research on elderly nutrition; these include calcium, vitamin D, B vitamins, vitamin A, zinc, sodium, and fats.

Other specific issues for congressional concern include these questions:

- *Does research on health promotion interventions for the elderly indicate that these interventions are cost effective?*
- *Should Medicare reimbursement categories be reconsidered with a view to increased reimbursement for health promotion/disease prevention interventions?*
- *How might Congress obtain more accurate and standardized evaluations of Federal food assistance programs in order to improve their general efficacy and their ability to reach specific target groups?*

Medications and the elderly*

Drug treatment is an important medical technology for older individuals. Those over 65 use 30 percent of all prescription drugs—twice as many as the average user. More than four-fifths of all noninstitutionalized older people use over-the-counter medications. The safety of using medications, availability of information about drugs, and new technologies that might improve how drugs are delivered and used are influenced by Federal policy.

As disease prevalence rises with age, drug use increases. The elderly use the everyday drugs consumed by the general population for colds, acute infections, and headaches. Chronic diseases such as arthritis, hypertension, and cardiovascular disorders, which are especially common in older people, determine the use of another group of drugs that includes diuretics, anti-hypertensives, anti-inflammatory agents, and cardiac drugs.

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*This issue is examined in detail in ch. 5.

THERAPEUTIC EFFECTIVENESS OF DRUGS IN THE ELDERLY

When carefully administered, drugs improve the condition of most elderly patients. Drugs are usually the most cost-effective way to treat chronic disease or manage its effects. Such benefits, however, can have unanticipated negative effects on some older people. The elderly have a higher incidence of drug side effects and drug interactions than younger age groups. Many problems of drug use among the elderly are due to altered metabolism, the presence of multiple diseases, and increased susceptibility to side effects. The effects of these factors are exacerbated when older persons take improper combinations of drugs, often unbeknownst to their doctors or pharmacists.

Few drugs are tested for side effects and therapeutic effectiveness specifically in the elderly. Recent studies of how drugs are distributed and metabolized in the body show significant differences between older and younger populations. These differences are based on age-related biological changes that affect the body's ability to process, store, and excrete drugs. It is not yet universally recognized, however, that the elderly require different drug treatment than younger adults.

The presence of multiple chronic diseases and their **treatment with multiple drugs** lead to a higher incidence of adverse drug reactions and adverse drug *interactions*. The threshold of toxic blood concentration is lower for the elderly for many drugs, leading to increased probability of overdose. This may be due to altered pharmacokinetics[14] in combination with increased susceptibility to adverse drug effects.

While **adverse drug reactions and interactions** account for 3 percent of all hospital admissions, they account for 12 to 17 percent of hospital admissions for those aged 70 to 90. Adverse effects are especially common for drugs used to treat cardiovascular and psychiatric diseases, both of which are prevalent among the elderly. Adverse drug reactions among the elderly are estimated to cost $3 billion per year.

Side effects of drugs may be more common among ambulatory patients than among hospital patients. Reporting of adverse effects is less reliable for ambulatory patients, and drug errors are more common outside the hospital. Increased prevalence of home care may exacerbate the problem of adverse drug effects and noncompliance with prescription instructions.

EDUCATION IN PROPER USE OF DRUGS

Appropriate use of drugs by the elderly can be facilitated in a number of ways. **Improved education of health care providers,** including physicians, can instill knowledge about proper use of drugs and increase awareness of the special biological and physiological characteristics of older patients. An experimental method now under way uses trained personnel to visit physicians to educate them about common prescription errors.

There is wide agreement on the need to improve physicians' awareness of drug therapy problems among older patients. A large study found that efforts to change physician habits reduced Medicaid costs significantly. The cost of educational materials and personnel for educating physicians was $93 per physician per year, which resulted in estimated annual savings of $205 per physician in Medicaid reimbursements.

Patient education is essential for the practical management of chronic conditions because the long duration of illness requires active patient participation. Information transfer is more difficult with older patients than the general population, however, especially for two groups—very old persons who are less educated and those who are confused. Heightened sensitivity among health providers to the need for adequate patient education could improve the efficacy of treatment; enhanced awareness among older patients could diminish anxiety and aid in the treatment process.

TESTING AND SURVEILLANCE

Although **drug testing** in elderly patients is not specifically mandated for inclusion in clinical trials performed for Food and Drug Administration approval, the recent trend has been to include more older patients. But there are no specific guidelines or regulations for assuring that clinical trials take account of the special drug needs of the elderly, in part because such requirements would complicate analytic procedures. Elderly subjects would have to be representative of the older population and its wide variety of chronic conditions. The high prevalence of disease among the elderly increases the "noise" level in drug reaction data, compounding the difficulty of detecting problems. To compensate for this factor, more elderly patients must be included in tests; this increases development costs and makes analysis more difficult.

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[14] Pharmacokinetics defines how drugs are distributed and metabolized in the body.

Increased use of **postmarketing surveillance** could contribute to establishing drug safety and efficacy; monitoring of actual drug use would help to identify unknown adverse reactions. Premarket test results could be supplemented by these procedures and safety would be encouraged by intensive surveillance. There are, however, problems with using postmarketing surveillance to assure safety; current methods of reporting adverse effects, for example, are unreliable.

Because older people often have multiple disorders that can be treated in a multiplicity of ways, and because of the plethora of potentially effective drugs that can be used, optimal treatments are often not apparent. Comparative studies of different treatment combinations for a set of conditions are often not available. The standard method for dealing with such uncertainty is the **randomized clinical trial,** the development of which was a major advance in modern medicine. Careful studies of different treatments under controlled circumstances could establish the best regimens.

Federal savings from support of randomized clinical trials might be obtained through reduced incidence of side effects from current treatment methods and by preventing unnecessary complications. The magnitude of savings, however, cannot be estimated because there is inadequate knowledge about the potential improvement in health that might arise from different treatments. Also, increased support for clinical trials is likely to be quite costly, and could divert Federal funding from basic biomedical and other forms of research.

SELECTED ISSUES

It is clear that considerable information is needed about issues surrounding drug use by the elderly. The Federal Government is directly or indirectly involved in a number of these issues. Considerations for congressional review include the following:

- *Should Congress require premarket testing and/or postmarket surveillance of drugs specifically in older population subgroups?*
- *How might Congress encourage improved education of both health care providers and older persons themselves regarding drug use by the elderly?*
- *Should Congress require improved labeling of over-the-counter medications to warn of possible dangers in their use by older persons?*
- *Should Congress extend funding for randomized clinical trials for drug treatments for diseases that are prevalent in the elderly?*

Changes in health services

*Information technology and health care of the elderly**

Ability of the elderly to use information technology and to participate more directly in their health care is of growing interest as new approaches to health promotion, disease prevention, and home health care are developed. Although information technology, particularly in computers and communications,[15] has had substantial impact on the health care system, relatively little attention has been devoted to applying this technology to the specific health needs of the older population, who stand to benefit significantly from its applications. This report thus focuses on the *potential* use of health information technology for both current and future cohorts of older persons. The elderly of the year 2000 will have considerably higher educational levels, and be more likely to be familiar with and to use information technology than those presently over 65. The difference in attitudes toward such technology will be even more dramatic when the baby boom cohorts, now aged 25 to 40, become eligible for Medicare early in the 21st century.

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*This issue is examined in detail in ch. 6.

[15] For purposes of this report, information technology is defined as the application of computers and telecommunications systems to the creation, storage, manipulation, and dissemination of information.

Although there is a dearth of computer applications of information technology for elderly persons in general, various computer-based technologies have been developed to assist the severely disabled and those suffering from chronic medical problems. Such **prosthetic technologies** include programmable wheelchairs, voice-activated robots that can literally "serve" paralyzed persons, and a variety of rehabilitation aids. Many of these technologies, however, are as yet either experimental, relatively expensive, or primarily applicable in health care settings.

New computer applications are expected to have widespread use in assisting those who are less impaired, including most older persons. The decade of the 1980s promises significant advances in the availability and use of personal computers for a multitude of functions that will aid all age groups in the population. Some of these new technologies will be especially beneficial to older persons who have decreased functional abilities and restricted mobility. Today, about half a million older persons are confined to bed; about 2 million have mobility problems around the home; and almost 3 million require the assistance of another person to perform activities of daily living. Information technology can enrich and improve the services that traditional health care institutions and professionals provide by disseminating information directly to older persons in their homes. This information could include methods for maintaining and improving health or ways to access needed services, and could be readily provided on video displays or in print, both to those at home and to wider audiences at senior centers, community centers, and congregate housing complexes.

USE OF INFORMATION TECHNOLOGY BY THE ELDERLY

There has been little study of the ability of older persons to use computers, and still less of their ability to use computers for health care. The little empirical evidence available indicates that—*contrary* to stereotypical views of the elderly—most older individuals are quite receptive to computer technologies. Demonstration projects have shown that older persons, after preliminary instruction, have a high degree of interest in using personal computers. Some older people enjoy programming and working with applications software, such as spreadsheets; others prefer recreational computer games and communicating by means of computers adapted to their capabilities. Because the older population is heterogeneous, particularly in terms of functional ability, some older persons require specially adapted computers. Although they vary widely in cost at this stage of development and marketing, computer consoles with larger keyboards and video display screens with larger displays are available to compensate for the sensory and functional impairments of some older persons.

Information technology can be used by the elderly for health purposes in two major ways. One is computer-assisted health instruction, which is a logical extension of self-care/self-help. It is estimated that at least 25 self-help programs for the elderly are now in operation, most of them developed by nonprofit organizations, but very few of these use *computer* programs. Most computer-assisted health instruction programs are used in health care settings to instruct patients, such as diabetic and post-stroke patients, who have specific problems. The steady growth of software for educating the general public about health maintenance and disease management outside of traditional care settings, and the trend toward specialized programs for subgroups of the population, signal the eventual evolution of home-based computer programs for the elderly. The relevance of this technological trend for use by and for the elderly is not yet widely recognized by either the private or public sector, but the market is expected to change rapidly during the next 5 years.

Self-help for health maintenance and disease management can also be *indirectly* assisted by existing computer technologies. Homes can be computer-monitored to assure proper heating, to control a variety of appliances, to provide wake-up services, and give audible reminders at medication times. Computers can be programmed to instruct older persons or their family caregivers on special diets, rehabilitation practices, and other medically related practices that promote their health. The safety of dependent older persons can be enhanced by alarm systems that notify central monitoring stations of trouble in the home. The alarm can be activated at any time by the individual or by an automatic signal if the monitoring unit is not reset within a predetermined amount of time. These and other technologies increase the ability of dependent older persons to remain in their homes and to be less dependent on personal care assistance.

A second important way in which the elderly can use information technology is by assisting health professionals to monitor the care of older persons. The use of home computers to augment professional care may enable chronically ill people to remain in their homes and reduce the need to make difficult visits to medical offices or to have care providers visit them at home. Blood pressure, pulse rates, body temperature, and heart electrical activity can now be sensed and measured by "smart" sensors that incorporate microprocessors. This type of personal home health monitoring system can provide daily appraisals of the patient's vital signs and store the data in a longitudinal record that can be used to monitor changes in those measurements. It can also include a voice chip for giving simple instructions and programmed advice for certain types of health regimens.

Measurements of other physical functions have recently been developed for use in rehabilitating handicapped patients. Some of these measurements have the potential for computer-based processing, and may also be applicable for monitoring the health status of older persons who are acutely ill or severely impaired. An **interactive telecommunications** system between the patient's home and the health care provider's office could be established to facilitate medical monitoring.

ACCESS TO HOME COMPUTERS

There are no data on the age of individuals who own or have access to personal computers in the home, and estimates of future penetration of the market vary widely. Estimates of the proportion of U.S. homes that will have computers by 1990 range from one-fourth to two-thirds. It is only certain that the market will greatly expand, especially as unit prices decline and program capabilities increase. The extent to which this growth will reach the older market is unclear.

There are a number of barriers to the use of information technology for health purposes by the elderly. One problem is the cost of the technology, which currently ranges from several hundred to several thousand dollars for a basic home computer system. Additional costs for software increase the economic burden. Another factor is the incompatibility of equipment among a great variety of systems, making the decision to purchase a particular unit more difficult. The elderly with functional impairments have unique access problems in that they often find it difficult to use computers designed for the general public, and the costs of custom-designed units remain high.

Self-health information and computer instruction technologies are themselves emerging fields, and as such are diverse and unsettled. In some cases, programs are developed by transient "entrepreneurs" who lack subject knowledge and are often forced out of the market. Other programs have excellent material that is developed by individuals who have expertise in subject content and computer technology. Most available software programs have not been evaluated. The serious issue of establishing criteria for evaluating computer-assisted instructional material is just beginning to be addressed.

SELECTED ISSUES

Because the application of information technologies to self-health care for the elderly is new, there has been little direct Federal involvement in the past. Some Federal demonstration program funds have been used to develop information system models for nursing homes. A more concerted Federal effort has supported research and development of information dissemination technologies for the handicapped, some of which are useful for older persons who are functionally impaired. Some executive agencies are now supporting demonstrations of home-based information technologies for health promotion; other agencies are considering funding investigations of the use of microcomputers and computer games to improve the social interaction and mental functioning of the elderly.

Additional research is needed on the role of information technologies in health maintenance and disease prevention for the elderly. This research should include evaluations of the quality of health instruction programs designed for older persons, problems in accessibility and use of computers by the elderly, and the cost-effectiveness and efficacy of information technologies for reducing the amount of personal home care required.

The major issues for congressional oversight in this area are:

- *To what extent, if any, should the Federal Government be involved in activities concerning the safety, cost, liability, and efficacy of computer-assisted health instruction programs for the elderly?*
- *Given existing authority, how can the Federal Government encourage the private sector to voluntarily develop appropriate health instruction technologies for the elderly that meet basic standards for quality?*

Functional impairment and long-term care*

Most older persons are able to carry on their regular daily activities in a variety of environments, but the incidence of chronic conditions and prevalence of functional impairments increase notably at the oldest ages. These problems are the major reasons for the long-term care needs of both the elderly who are institutionalized and those who live in the community. As the number of Americans over 65 rises, the corresponding rise in the number of "very old"—those over 85—will dramatically increase the need for long-term care services. This need will be exacerbated by the new prospective payment system under Medicare, which is expected to limit hospital length-of-stay and encourage early release of older patients, many of whom will still require rehabilitative or other types of long-term care at home.

Long-term care services are provided by nursing homes, board and care facilities, and home health care agencies. In some communities additional services are provided in adult day care facilities, hospice programs, and congregate housing facilities. Little information is available about differences in the services that agencies provide or the types of older persons served, in part because of differences among State programs that support community-based long-term care services. It is known, however, that a wide range of services is provided to a great variety of older clients, and that there is both lack of coordination and duplication of services in many communities.

EXTENT OF NEED FOR LONG-TERM CARE

In general, community-dwelling persons over 85 are *six times* more likely than those aged 65 to 74 to be dependent in basic or instrumental **activities of daily living**[16] and to need the assistance of another person. As the proportion of very old persons in the older population increases, the demand for long-term care services will grow. Greater strains will be placed on families and other informal caregivers, who currently provide up to 80 percent of long-term care for the elderly. This level of **informal support** is expected to change for a number of reasons:

- The older the person, the less likely he/she is to have a spouse to provide assistance; this is especially true for women over 85.
- The higher the number and severity of functional impairments, the lower the likelihood

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*These issues are examined in detail in ch. 7.

[16] Basic activities of daily living include dressing, eating, bathing, toileting, walking, and getting in or out of bed. Instrumental activities, also called home management activities, generally refer to tasks such as shopping, cooking, doing house and yard chores, handling money, and driving.

that family and friends can provide the degree of assistance required.

- Because most family caregivers are women, the increasing proportion of adult women in the labor force will reduce the number available to provide informal support to an elderly parent.

Greater demands will be placed on existing long-term care agencies to respond to the changing characteristics of the older population and its informal support network. Yet the complexity, fragmentation, and limited scope of long-term care services in most communities make it difficult for individuals and their families to understand what formal services and alternatives are available. The problem can be particularly troublesome for dependent older persons who are alone. One of the greatest fears of the elderly is that they may become frail and dependent on others, even though assistance might be readily available. This concern can be ameliorated by a logical and well-coordinated national system of long-term care services that includes expanded use of technologies in the health care setting, the home, and the community.

TECHNOLOGY AND LONG-TERM CARE

Technology has not been widely used in long-term care services for the elderly. Identification of **appropriate technologies** for this population requires accurate assessment of their needs. Such assessment is hindered by the fact that Federal and State programs, which regulate and fund more than half of all long-term care services in the United States, influence the kind of needs that are recognized. By emphasizing medical and skilled nursing care, these programs tend to obscure the need for other types of supportive services.

Although existing medical technologies can treat some of the chronic conditions that cause functional impairment, most chronic conditions are not curable. Given the lack of effective cures or prevention, effective **management** of chronic conditions becomes important. This can often be achieved with appropriate drug therapy, personal care services, and use of technologies that compensate for decreased function (e.g., prostheses, assistive devices such as walkers, chair lifts, vision and hearing aids). Many of these assistance methods need further development to expand their usefulness. While biomedical research generally focuses on acute conditions that cause death, expanded research on the chronic conditions that cause functional impairment could result in effective treatments or prevention strategies, as well as prosthetic or management technologies that promote independence and decrease the need for long-term care.

Alternative approaches to maintaining independence or compensating for functional impairments are needed, such as assessment technologies, assistive devices, and rehabilitation techniques. **Assessment technologies** can play a significant role by focusing on the various chronic conditions that lead to functional impairments and the types of resources available to assist the individual. But the prevailing emphasis on medical and skilled nursing care has limited the use of assessment technologies, both in long-term care institutions and in the community. At the same time, the new Medicare prospective payment system for hospital care, based on Diagnosis Related Groups (DRGs), will encourage the earliest possible release of older patients, which increases the importance of adequate discharge planning and use of appropriate assessment technologies. Yet physicians and other health care providers generally lack training in the use of such measures, and there is disagreement about the reliability and validity of existing assessment technologies.

Assistive devices are available to compensate for some impairments in hearing, vision, walking, and other functions. Various other devices can assist the moderately impaired in preparing food, eating, performing household chores, and managing other activities of daily living. These devices range from simple and inexpensive to complex and quite expensive. In most cases their costs are *not reimbursable* under Medicare or Medicaid provisions; this factor can limit their use by older persons. Other factors restricting their use include lack of information about available devices, the difficulty of selecting appropriate devices for individuals with multiple impairments, and negative attitudes of elderly individuals, their families, and many health care professionals about the usefulness of the products.

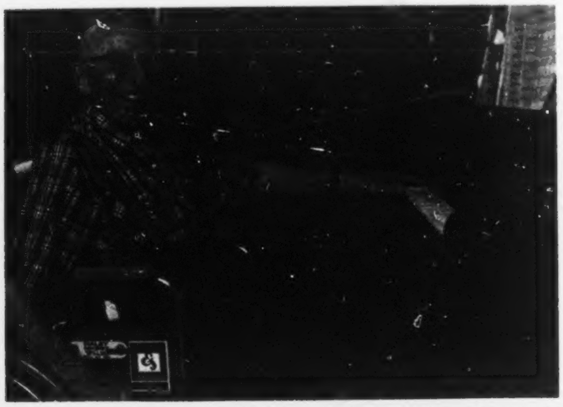

Photo credit: M. Holtby, ®Seniors' Resource Center, Jefferson County, CO

Assistive devices helped the impaired elderly to remain active.

Another growing need is the availability of **rehabilitation devices and techniques** for post-hospitalization care in the home. The implementation of DRGs under Medicare is likely to increase the need for medical technologies that can be used for outpatient and in-home rehabilitation. The need for new devices to assist in the rehabilitation of older persons will grow, but their cost and complexity may limit their availability. As with assistive devices, negative attitudes toward the rehabilitation potential of older persons may restrict the use of those devices that are available.

PREVALENCE OF MENTAL AND PHYSICAL IMPAIRMENT

Some elderly individuals have **mental conditions** that can cause functional impairment or increase their degree of physical dependency. The degree of physical and mental impairment is related to need for long-term care and the risk of institutionalization. About half of all residents of nursing homes and board and care facilities have some degree of mental confusion. But the proportions of these individuals who are functionally impaired because of mental confusion and the proportions who are impaired by *both* physical and mental conditions are not known. Nursing home residents are more likely to have severe mental confusion and to be highly dependent in the basic activities of bathing, eating, and toileting. Some data on nursing home residents show a high statistical association between mental confusion and degree of physical impairment, particularly in the areas of severe incontinence and inability to bathe or feed oneself. Persons with both mental and physical impairments usually require 24-hour care, which is a great burden for most caregivers.

There appears to be a *critical threshold* of physical and mental impairment, beyond which family caregivers can no longer effectively care for the dependent person and are usually forced to rely on institutional care. Despite the great difficulties that families and health care providers must face in caring for these highly impaired individuals, little public or private sector attention has been given to the development of devices and care techniques that might help resolve the more severe problems.

Although most patients who are severely impaired mentally and physically may require skilled nursing care, some need only 24-hour supervision and personal care services. Yet existing health care reimbursement programs encourage admittance of these persons to nursing homes rather than to less restrictive and usually less costly board and care facilities. Similarly, individuals who need personal care and supportive services at home may not receive the care they need or may receive unnecessary health care services because of Medicare and Medicaid funding regulations. Negative attitudes about the concept of custodial care, and fears about the cost of providing nonmedical long-term care services for the functionally impaired elderly, also limit the availability of these services.

USE OF AVAILABLE TECHNOLOGIES

Most long-term care services are labor-intensive, and formal and informal providers receive little training in the use of devices and techniques to facilitate caregiving. Increased development and use of these technologies could lessen the burden of caregiving, allow elderly persons to remain at home longer, and decrease staff turnover in long-term care facilities. Technologies to assist patients and caregivers are used more extensively in Europe than in the United States. Western European countries generally provide a greater range of supportive environments and residential facilities to assist impaired individuals and their caregivers.

Few *medical* care technologies have been used in long-term care facilities or in the home. The recent implementation of the Medicare prospective payment system and increased emphasis on the provision of health care services at home should broaden the demand for home-based medical care technologies. This trend is expected to grow, as is demand for sophisticated medical and nursing care technologies in nursing homes. Increased use of these technologies outside the hospital will depend to a large extent on public and private reimbursement policies for costs of nursing home and home care services, and on the availability of skilled health care personnel trained to use these technologies and to teach the patient and the family to use them.

These changes will require better methods of patient assessment and increased coordination of the caregiving network to promote a continuum of care based on categories of need among different groups of patients. Efforts to improve service delivery have included techniques for coordinating services at the community level, case management systems, and organizational approaches that provide a range of services through a single local agency. Development of a more coordinated system of services could enhance the ability of some elderly individuals to remain at home and to plan effectively for their own long-term care.

SELECTED ISSUES

Because the demand for long-term care services is expected to continue its rapid growth, additional information will be required to develop and evaluate alternative approaches to caregiving for functionally impaired older persons. A fundamental need is expanded basic research on the chronic physical and mental conditions that cause impairment. Given the prevalence of existing conditions, additional research is needed for development, utilization, and evaluation of technologies to meet the needs of the long-term care population. Devices and techniques to assist older persons with multiple impairments and mental confusion need to be developed. Accordingly, more information is needed on the relationship between mental confusion and functional impairment, and on the impact their severity has on the demand for different types of long-term care. Improved methods are needed to reliably assess the extent of chronic conditions and impairments as well as the devices or techniques that can best ameliorate them.

Most of these research areas are related to other issues for congressional review regarding the growing need for long-term care. These include:

- *Should Congress promote the expanded development and use of comprehensive assessment technologies for the community-dwelling and the institutionalized elderly?*
- *Should Congress mandate additional funding for long-term care services—based on degree of functional impairment—delivered in the home and in care settings other than nursing homes?*
- *Should Congress implement policies to increase the use of assistive devices and rehabilitation technologies in the home and in other long-term care settings?*

Health care costs*

Health care spending has been rising and will continue to do so under present policies, but the growth in numbers of those over 65—particularly those over 75—will intensify demand for acute and long-term care services. Recent data indicate that about one-third of all health care expenditures are by the elderly, and that up to 30 percent of all Medicare payments are made for care of persons in the last year of life. But the growth of the elderly population is *not* the main reason for the rapid escalation in health care costs, which have been increasing at almost *three* times the general rate of inflation during the past 5 years. Health care expenditures in 1982 totaled more than $322 billion, an increase of almost 30 percent since 1980. In 1983 total health expenditures rose an additional 10 percent and reached $335 billion—comprising more than 11 percent of the gross national product. The dramatic increases are largely due to intensification of services, expanded availability and use of costly diagnostic and treatment services and technologies, and the rising cost of labor. This excessive inflation in health care costs has led to concerted efforts to contain spending, which have far-reaching implications for older Americans.

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*This issue is examined in detail in ch. 8.

DEMAND FOR HEALTH CARE

Demand for health care by older persons is influenced by physical, psychosocial, and economic factors. The increased use of services by some older persons is usually due to their increased burden of illness. The remarkable recent decreases in mortality among those over 65 have not been accompanied by similar decreases in morbidity. Moreover, older persons tend to underreport symptoms of chronic conditions. Some studies have shown an average of **three correctable problems** per elderly patient; many of these problems could have been identified earlier by using functional assessment measures or by using greater care in taking the patient's history.

While most older persons are functionally independent, many require health care for chronic conditions that increase in prevalence with age. Spending for health services represents a major problem for both elderly individuals and the Federal Government. Medicare provides an important health care subsidy for those over 65, but it is by no means comprehensive—many necessary services and technologies that affect health and functional status, such as dental services, eyeglasses, and hearing aids are not reimbursable. The growing need for long-term care as age rises means that increasing proportions of the elderly population whose financial resources become depleted have to rely on public means-tested programs such as Medicaid and Supplemental Security Income for the cost of long-term care services. Private financing mechanisms such as "medigap"[17] or other types of private insurance do not provide adequate supplemental protection. The few private insurance policies that are available for long-term care, especially for nursing homes or skilled care at home, are extremely selective for participation and very expensive. Yet one-fourth of all health expenditures by the elderly are for nursing home care, of which public programs (primarily Medicaid) pay about one-half. The increases in these costs show no sign of abating, as more expensive technologies become available and the need for care grows within the aging population.

COST-CONTAINMENT EFFORTS

Cost-containment efforts to date have not been effective in controlling overall health spending, whether by individuals, the Federal Government, or third-party payers. Most approaches have focused on hospital care and rate-setting, as in the new Medicare prospective payment system. The response of the health industry has been increased **shifting of services** to ambulatory settings (e.g., outpatient and rehabilitative care) or **shifting costs** to other Federal programs, other insurers, and consumers. Attempts to shift a greater share of costs to consumers in order to minimize overutilization of health services have tended to reduce the number of persons seeking care, but have not changed use-patterns after a diagnosis has been made. Capitation approaches have been most successful in encouraging the substitution of lower cost services for expensive hospital care. Recent experiments are extending the capitation concept to include supportive social services.

The coordination of services and benefits among Medicare, Medicaid, and other public programs that influence health care remains a problem in access to care for the elderly. Poor coordination can increase costs because the most appropriate services are not provided; better coordination may increase utilization and overall costs, but can also improve the quality of care and reduce the need for acute care. The incremental costs and benefits of each action must be evaluated.

As has been noted, attempts to control Medicare costs through prospective payments could affect quality of care for patients in hospitals awaiting placement in long-term care institutions. Premature discharge may result in multiple admissions and shifting costs to home care, increasing overall costs for these patients as they are cycled back and forth between inadequate community settings and the hospital.

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[17] Medigap insurance has been developed by the private sector to help patients cover the cost of medical expenses not reimbursable by Medicare.

Other reports have addressed cost-reduction questions related to changes in eligibility, benefits, and financing mechanisms for the existing Medicare program. Recent Congressional Budget Office reports explore options to increase revenues or decrease outlays as well as potential schemes to tie deductibles to income level. This assessment concentrates on the cost-containment issues in Medicare and Medicaid as they relate to the aging of the population, the demand for health services and long-term care, and changes in technology.

SELECTED ISSUES

The volatility of health care costs in recent years has spurred considerable research and evaluation at all levels of government and in the private sector, but significant gaps in knowledge remain regarding such questions as how to maintain quality and access to care while promoting cost-effectiveness and cost reductions. More information is needed on the range of factors that affect the use of health and long-term care services by the elderly. Research is needed on how to improve measures of health outcome, better strategies for educating consumers, and alternative methods for financing health care and long-term care.

Specific issues regarding health care cost-containment strategies and their effects that are likely to face Congress include:

- *Should Congress strengthen the quality assurance mechanisms for health care services because of possible adverse effects of cost containment?*
- *How might Congress stimulate coordination among preventive, social, long-term care, and acute care services to promote efficiency and reduce costs for unnecessary types of care?*
- *What types of function-enhancing technologies can be encouraged to reduce the need for health care services?*
- *Should Congress act to increase coordination among Federal and State programs to avoid unintended interprogram cost-shifting?*

Social changes in the living environment

*Housing and the living environment**

The housing environment takes on greater significance as people age—especially in terms of lifestyle continuity, neighborhood familiarity, physical security and safety, and emotional sustenance. Although the older population has the highest percentage of home ownership, physical housing deficiencies and excess cost burden also tend to be higher among many subgroups of the elderly. Resolving these problems may require new and specific types of Federal assistance. Of particular concern is the growing number of very old persons who live alone, especially those who have functional impairments. For these individuals, informal supports from family and friends often mean the difference between institutionalization and continued residence in their homes. New technologies and services, when combined, could provide increased assistance for maintaining independence in the household, especially as the availability of informal support shrinks.

ELDERLY HOUSEHOLDS AND HOUSING TENURE

During the last two decades, the number of elderly **households** has risen proportionately more rapidly than the number of elderly persons. Changes in living arrangements, especially the growth in numbers of older persons living alone, have contributed to this trend. The proportion of U.S. households headed by an older person has increased from 15 percent in 1950 to more than one-fifth today. Marital status and living arrangements have also changed since 1960, due in large part to sex differences in life expectancy. More than *four times* as many older women as men live alone; more than three-fourths of older men but less than two-fifths of older women are married and living with their spouse. Most recently, the proportions of older men and women who live with nonrelatives have decreased. This trend is particularly evident among women over 85, who are also far more likely to live alone or to be institutionalized.

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*These issues are examined in detail in ch. 9.

Approximately three-fourths of all elderly households are **owner-occupied,** of which four-fifths are owned **mortgage-free.** The growth of housing ownership by the elderly has continued unabated since World War II. Since 1980, despite an increase of more than 1 million elderly households, there has been a net *decrease* in the number of renter-occupied elderly households. Although Federal housing programs and subsidies for the elderly have been directed at rental units for low-income persons, there is growing awareness of the particular problems of—and possible opportunities for—elderly homeowners.

HOUSING PROBLEMS AND FEDERAL PROGRAMS

Housing tenure of the elderly tends to correlate with various social and demographic characteristics related to need for assistance. Rented units are far more likely than owned units to be occupied by one person. Because single-person units among the elderly are highly likely to be occupied by women, they are also twice as likely to have households with incomes below the Federal poverty level. Renter-occupied units are also more than twice as likely to have physical and maintenance **deficiencies.** Elderly owner-occupied households, which also have these types of deficiencies, may also face the problem of **excess housing cost burden,** especially for those elderly persons on fixed incomes who still have a mortgage indebtedness.

Federal housing policies to assist the elderly have concentrated on the problems of low-income renters through major programs such as Section 8 rental subsidies, low-rent public housing, and Section 202 rental housing for the elderly. But these housing programs for the elderly have been narrowly directed toward building construction and provision of rental units, with little attention to **special design** features that respond to the physical and psychosocial needs of older persons. In the past, the design of some federally subsidized high-rise housing projects for the elderly increased the likelihood that the residents would become isolated, injure themselves, or be victims of crime. Also, only limited Federal efforts have been directed at preserving the housing stock or promoting rehabilitation of elderly dwelling units—either rented or owned.

Until recently, no attention was given to the **coordination of housing programs with services** needed by elderly residents. The need for services is growing as the older population ages and as the first cohorts of elderly tenants in public housing and Section 202 projects "age in place." A similar process is occurring in suburban neighborhoods, where the number of elderly residents is growing rapidly. These new cohorts of old and very old homeowners and renters have greater needs for assistance in transportation, household chores, dwelling maintenance, and access to community-based services. The preponderance of older persons living alone and the lack of available support from family and friends—especially for those over 75—exacerbate these problems and increase the degree of assistance needed.

HOUSING OPTIONS FOR THE ELDERLY

Federal housing programs need to recognize the **heterogeneity** of the older population and to induce development of a range of housing options that provide varying levels of support. Existing rental unit subsidy programs could be better integrated with congregate services and community programs for the elderly. They could also encourage housing alternatives such as **shared housing.** Shared housing programs provide income to older homeowners while supplying rental space at affordable prices. Other advantages of such programs are efficient utilization of excess housing space, reduction of social and physical isolation, and provision of informal supports for older persons. Intergenerational shared housing promotes interaction and assistance between generations.

Other housing options include accessory apartments or "echo" (elder cottage housing opportunity) housing. **Accessory apartments** are usually created within single-family residences. The house is converted to accommodate a separate apartment with little or no change in the home's *outside* appearance. Preservation of neighborhood character is an important element in the acceptability of accessory apartments in most communities. Modular bathroom and kitchen units have made such conversions more efficient and less costly. **Echo housing units,** also called **"granny flats,"** are compact, efficiently designed, temporary structures that are erected in backyards of family homes and designed for use by elderly relatives. The standard unit is a modular three-room house of about 600 square feet.

Despite their efficiency and low cost, these housing options for the elderly face opposition in local communities that seek to preserve single-family zoning laws. These neighborhoods are the most likely sites for echo housing and accessory apartments, but are also the most likely to *resist* changes to the single-family nature of the neighborhood. Yet the Census Bureau estimates that there are more than 2.5 million accessory apartments in the United States. Echo housing, which cannot be concealed within an existing unit, is far less prevalent.

In addition to federally subsidized housing for the elderly, other types of **congregate housing** have been developed by the private sector. **Life care, continuing care,** and **residential care communities** are analogous terms for communities in which older persons pay a large entrance fee and a monthly service fee to live in a unit within a complex that typically provides supportive and health care for the remainder of the person's life. There are more than 100,000 elderly residents in 300 such complexes in the United States, some of which have already experienced financial trouble. Financing problems usually arise because of unsold units, lack of initial capital, and underestimates of actuarial cost factors for providing lifetime care to the residents. Fewer than 15 States have laws governing the operation of life care communities and no Federal protections exist. Some of the newest housing developments provide residential care, but do not offer lifetime care contracts to prospective residents.

Other supportive environments include **board and care homes** that range in size and type. Some have only a few residents and others are large residential care facilities. They also differ in the types of residents they accommodate and the types of supportive services they provide, with some caring for mentally impaired and frail individuals, many of them elderly. Most board and care homes are State-licensed and a majority of their residents receive public income maintenance subsidies. More information is needed about the range of facilities that exist and the types of residents they can accommodate. It appears that some persons who are in need of long-term care can be well served in such facilities rather than in more costly nursing homes.

IN-HOME TECHNOLOGIES

Many possibilities exist for applications of technologies in the home to assist older persons in maintaining independence and adapting the environment to meet their needs. These technologies, in conjunction with appropriate design of the dwelling unit, can enhance the older person's **"environmental fit"** and **competence,** both of which enable him to control his environment. New, relatively inexpensive technologies allow housing to be readily adapted for the impaired or retrofitted with improved safety and communication features. **Low technologies** include simple ones that promote mobility, such as safety treads on stairs and in bathtubs, handrails and grab bars, and ramps. Many simple technologies can mitigate the common problems of reduced vision and decreased grip strength in the elderly—including door handles in place of door knobs, special controls for major appliances, jar openers, adaptive utensils, and other household gadgets. Various dressing, bathing, and grooming aids are available to compensate for the impaired person's decreased tactile ability and lessened agility, particularly from arthritis. Zipper pulls, "velcro" fasteners, and hand-held shower sprayers are a few examples.

High technologies are more complex and have widespread applications in the home. Especially helpful are communications technologies, such as automatic alarm and telephone dialing systems for emergency help (including electronic monitors that detect falls or injuries), portable telephones, and other security devices. Electronic safety systems are available to "program" appliances to shut

Photo credit: Roger Austin, Peterborough Development Corp.

Supportive housing environments can promote the independence of elderly residents.

off after predetermined lengths of time or to monitor and control heat, air-conditioning, and lighting. In-home computers can provide various self-instruction programs for medication, nutrition, and other self-care assistance. They can also provide "catalogs" of products for in-home comparison shopping. Modems for personal computers will enable older persons to communicate for a wide range of purposes, such as banking and bill-paying from the home; some health monitoring can be accomplished with interactive computers. Interactive television and "videotex" telecommunications allow individuals to compare, select, and purchase a wide range of goods and services without leaving the home.

OTHER HOUSING OPPORTUNITIES

New financing instruments provide other possibilities for enhancing the older person's housing options. New **equity-based financing instruments** can help some elderly homeowners increase their income and remain in their homes. Reverse mortgages typically allow elderly homeowners to convert up to 80 percent of their home equity into monthly income for a specified period of years. The homeowner retains ownership, but reduces his equity in the home over time. As currently offered, most reverse mortgages require repayment of the full loan amount (the total of disbursed monthly payments plus accumulated interest) at the end of the loan period (usually 5 to 12 years). New instruments may soon be marketed that will not include the payback requirement at the end of the loan period, but still allow the older person to remain in the house.

A second type of home equity conversion is the sale-leaseback plan, in which the older homeowner sells his house to an investor in return for the right to lease back the house for the rest of his life. The typical sale-leaseback plan includes a downpayment to the elderly seller, who carries an interest-bearing note for the balance of the purchase price, paid in monthly installments over a period of years related to the seller's life expectancy. Advantages to the seller are the right to remain in one's home for the rest of one's life, to pay a fair rental, to receive full price for sale of the house, and to earn interest on the note. The buyer's advantages include depreciation of the rental property, income tax deductions, and any appreciation in the house's value over time. Either of these procedures for home equity conversion requires consumer protections and counseling for the parties involved.

SELECTED ISSUES

The range of housing problems and options for the elderly is expected to grow because of the increasing number of homeowners and the heterogeneity of the older population. Research into these options should include more extensive analyses of shared housing, accessory and echo housing, board and care homes, and life care communities. Too little is known about each of these options, the types of consumer safeguards that may be required, and the potential role of the Federal Government in promoting their availability for the elderly. Home equity conversion plans require greater review and the opportunity to develop new instruments in response to consumer demand and requirements for consumer protection. The range of in-house technologies should be evaluated by appropriate Federal agencies for safety and efficacy.

This research can be supported by direct Federal involvement or by incentives to the private sector, especially the housing and finance industries. The growing involvement of the private sector in development of retirement and life care communities, in manufacture of modular housing, and in the production and marketing of hundreds of in-home devices attests to this potential.

The following questions suggest areas for possible congressional consideration:

- *Should the Federal Government expand existing programs that assist low-income elderly homeowners who have housing deficiencies and excessive cost burdens?*
- *How might Congress encourage utilization of technologies that promote the independence of older persons who are either slightly impaired or restricted in managing major activities in the home?*
- *Should Congress provide support for public and private sector efforts to develop new housing construction and design technologies that assist older persons in the home?*
- *Should Congress promote the expansion of public and private housing alternatives for older Americans?*

Work-related changes

*Workplace technology and the employment of older adults**

The structure of the American economy has undergone major changes since the mid-1800s, when it was agriculturally based and farm workers constituted two-thirds of the labor force. The United States had become an industrial nation by the 1920s, when more than two-fifths of all jobs were in manufacturing industries and only about 1 in 10 workers remained in farming. During the 20th century the mechanization of farming and the automation of manufacturing have ushered in a new economic era increasingly characterized by service sector occupations. Only 3 percent of today's labor force is employed in on-farm agriculture, while 23 percent are in manufacturing, and more than 60 percent are in the service and trade sectors. These changes are expected to continue as the economy becomes increasingly dominated by the electronics revolution and the service sector jobs it creates.

TRENDS IN LABOR FORCE PARTICIPATION OF THE ELDERLY

These trends have been accompanied by the aging of the U.S. population and a marked decline in the labor force participation rate of persons over 55. Workers now 45 and over may be particularly vulnerable to the latest changes in the work force. Older workers are primarily located in industries and occupations that were growing when they entered the labor market; many older workers are employed in manufacturing, which expanded in growth through the 1940s. Manufacturing and related industries—and their share of the labor force—began to decline in importance during the 1950s, by which time the earlier young cohorts of workers in these industries were "aging in place."

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*These issues are examined in detail in ch. 10.

The explosion of **workplace technologies** during the last two decades has threatened the previously secure future of these older workers. Although there is no *direct* evidence that significant numbers of older workers have been displaced by workplace technologies (e.g., union seniority rules in many manufacturing trades tend to protect older workers from unemployment), there is concern that future cohorts of older workers—those who are now aged 35 to 45—will face such possibilities. Recent advances in medical technologies, computers, and robotics[18] have led to the development of new occupations in a variety of high-technology medical care services and in computer programming, operation, and repair—jobs from which workers over 45 are likely to be excluded due to lack of appropriate skills. To remain employed, some older workers may need to accept low-skilled, low-paying jobs, or receive extensive on-the-job training. The likelihood that unemployed older workers will find employment at their previous pay level is expected to be significantly diminished.

EFFECTS OF TECHNOLOGY IN THE WORKPLACE

It is becoming increasingly likely that the pace of technological change in the workplace will present problems for older workers of the 1990s and the turn of the 21st century unless they are trained for positions in the growth sectors of the labor force. Although projections vary, one set indicates that by the year 2000 employment in service occupations will comprise about 85 percent of all jobs. Jobs in manufacturing will have declined to about 11 percent of the total. Meanwhile, as technologies evolve, many jobs in declining industries are either being replaced by automation or disappearing. Jobs in the manufacturing, farming, and private household service sectors, which have high proportions of older workers, are declining most rapidly.

Technology may adversely affect older workers' potential to keep these jobs, but it is also likely to improve working conditions, promote safety, and expand opportunities for other workers over 45. Technology is creating new jobs in many industries that currently have high proportions of older workers who can be retrained for these positions (e.g., steel factory floor foremen have been trained to operate computerized control centers instead of supervising "from the floor"). New service industry jobs and more clerical jobs may offer security to some older workers whose skills will remain in demand. And the possibility of doing today's jobs in tomorrow's **"electronic cottage"** (the computer-based office at home) may provide opportunities for older workers who want to work on a part-time or flex-time basis and/or obviate daily travel to work (clerk typists and stockbrokers, for example). Nevertheless, older workers will need to compete with younger workers who may seek similar flexibility in their job structures. The continuing influx of women into the labor force will intensify this competition.

Technology can benefit older workers who have **physical impairments.** Assistive devices, computers, robots, and other workplace technologies can compensate for waning physical strength, dexterity, eyesight, or hearing and can help improve employment prospects for those not ready for retirement. Workers of all ages can be protected by technologies that replace physically hazardous jobs or those involving dangerous chemicals and materials. There is evidence of long-term health hazards from certain dangerous jobs—hazards that are usually manifested in chronic conditions later in life. These health conditions are cited as reasons for early retirement by a significant number of older retirees. Replacing these jobs and providing opportunities for other work are likely to help older workers who choose to remain in the labor force.

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[18] There are an estimated 7,000 industrial robots now in use in the United States. Some 200,000 are projected to be in place in all types of industries and work settings by 1990; this figure may reach 1 million by 2000.

RETRAINING OF OLDER WORKERS

Retraining of adult workers will grow in importance as changes occur in the nature of jobs and the composition of the labor force. Few training or retraining opportunities are currently available to older workers, especially those with little education and in low-skilled occupations. This situation is likely to change as the population ages and fewer young workers are available for the work force. Indeed, the demographic trend toward greater proportions of older workers may coincide nicely with the projected creation of new jobs in **geriatric occupations,** such as geriatric service counselors and health rehabilitation technicians. Other projections indicate that the aging of the population, combined with the higher educational levels of future older populations, will increase retraining opportunities and the prevalence of second and third careers in a person's lifetime. Retraining could then be far more common and a repeated element in the lives of most workers, regardless of age.

Other types of technological changes will influence the number of persons who choose to retire into a healthy and economically secure future. Current changes in the workplace, in pension planning opportunities, in health promotion, in the home, and in the management of chronic conditions later in life may support a continued trend toward early retirement. In 1983, 17 percent of men over 65 were still in the labor force, compared with almost 50 percent in 1950; for women in that age group, the change was from 10 percent in 1950 to 8 percent in 1983 (less dramatic reductions occurred for men over 55, but an *increase* from 27 to 42 percent occurred for women aged 55 to 64 during the same period). If these retirement trends continue and life expectancy improvements accelerate as in the recent past, the falling ratio of workers to retirees will place ever-greater pressures on the Social Security system.

In sum, technology can both hinder and enhance the ability of the older worker to continue working. Although present circumstances do not warrant immediate large-scale concern, the future growth of technology and its effects on workers will need scrutiny by policymakers to improve the quality of worklife and provide job security for adult workers who wish to remain in the labor force as long as possible. Adequate income maintenance must also be targeted for congressional oversight, on the assumption that retirement patterns, whether voluntary or involuntary, will continue at their current level.

SELECTED ISSUES

As is the case with medical advances, accelerating technological change is most evident in the workplace. Although projections abound regarding the changing nature of the occupational structure during the next 15 years, there is very little accurate information available on either current or potential impacts on older workers. Moreover, little information exists on whether older workers are, in fact, displaced by technology or whether certain technologies instead enhance their employment opportunities. More research is needed on the functional capabilities of older workers and the precise reasons for the retirement decision. Informed policy will require specific data on the relationship between older workers' attitudes and their actual employment behavior, including the role of factors such as flex-time and part-time work opportunities, possibilities for retraining, amount of retirement income expected, social characteristics, and technological applications in the work environment (i.e., the workplace or the home).

The following questions reflect some of the immediate concerns that arise for congressional review about technological impacts on older workers:

- *Should Congress encourage the use of assistive devices and electronic technologies in the workplace to enable older workers with physical limitations who wish to remain in the work force to do so?*
- *Should Congress devote Federal resources and provide incentives to the private sector to retrain older workers for needed skills?*
- *How might Congress respond to the desires of some older retired persons for alternative work options such as flex-time, part-time, and electronic cottage employment opportunities?*

Conclusion

This review of the relationship between technology and aging has stressed the importance of functional ability and the vitality of older Americans for maintaining their independence, maximizing their options, and improving their quality of life. The ongoing aging of the U.S. population is likely to increase the demand for long-term care and the need for increased assistance as the growing proportion of those over 75 face a combination of incapacitating and largely unavoidable infirmities. Some existing technologies can mitigate these problems and others may arise to prevent or delay their onset.

Technology has also been the major factor in the growth of the older population and its increased longevity. The mortality rates of all elderly subgroups have entered a new era of accelerated improvement, indicating even greater gains in numbers than had been anticipated. Technology can respond to these trends by providing knowledge and ways *to apply* that knowledge in the workplace, the home, the health care setting, and the community to enhance the well-being of the elderly. At the same time, the swift pace of technological change poses new challenges to society in responding to the effects of such change. Among the challenges are:

- continual adaptation and retraining for new skills in the workplace;
- providing home environments that promote functional independence;
- encouraging greater involvement of individuals in their own health maintenance;
- assuring that those in need of assistance and supportive services are appropriately served; and
- utilizing the many resources of older Americans.

It is clear that a major challenge into the 21st century will be the maintenance of the health and functional ability of the older population, particularly as the proportions in the oldest ages rise to unprecedented levels. In so doing, society will share the countless benefits that a healthy and vital older population can contribute.

Chapter 2

Introduction: Technological Change and the Older U.S. Population

Contents

Page
Introduction 33
  Approaches to Technology 33
  Aging and Technology 33
Organization of the Report 34
  Major Areas of Concern 34
Demographic Background 35
  Definitions 35
  Demographic Projections of the Elderly Population 38
Demographic Trends 40
  The Growth of the Older Population 40
  Changes in Average Life Expectancy 41
  The Aging of the Older Population 41
  Trends in Life Expectancy by Sex and Race 43
  Major Causes of Death in Old Age 47
  Future Life Span and Prevalence of Chronic Diseases 48
Implications of Chronic Disease and Disability 51
  Severity of Chronic Conditions and Patterns of Institutionalization 52
  Chronic Conditions Among the Community-Dwelling Elderly 54
  Socioeconomic Characteristics and Sources of Assistance 55
Chapter 2 References 56

Tables

Table No. *Page*
1. Growth of the Population Aged 55 and Over, by Selected Age Groups, 1900-2050 .. 39
2. Life Expectancy at Birth and at Age 65, by Race and Sex, United States, Selected Years, 1900-82 42
3. Relative Distribution of the Population Aged 65 and Over, by Selected Age Groups, Selected Years, 1960-2020 42
4. Average Annual Percent Change in Age-Adjusted Death Rates for Persons Aged 65 and Over, by Sex and Age, United States, Selected Periods of Years, 1940-80 44

Figures

Figure No. *Page*
5. Schematic Representation of Cohort Data and Period Data 37
6. Age-Adjusted Mortality Rates for the Population Aged 65 and Over, by Sex, United States, 1940-80 43
7. Average Life Expectancy at Birth, by Race and Sex, United States, 1900-80 44
8. Average Life Expectancy at Age 65, by Race and Sex, United States, 1900-80 45
9. Population Pyramids, by Age and Sex, United States, 1960-2030 46
10. Past, Current, and Projected Ideal Survival Curves for the Population, United States, Selected Years, 1900-80 49
11. Projections of the Nursing Home Population Aged 65 and Over, United States, 1980-2050 53
12. Limitation of Activity Due to Chronic Conditions, by Degree of Limitation and Selected Age Groups, 1981 54

Chapter 2

Introduction: Technological Change and the Older U.S. Population

Introduction

Technology, in conjunction with economic, demographic, and social factors, affects the nature, impact, and course of social change. It plays, and will continue to play, a pivotal role in the aging of the U.S. population. The myriad approaches to understanding the interactive nature of technological, demographic, social, economic, and political processes are often one-dimensional or narrowly focused, yielding parochial conclusions that take inadequate account of the effects that different variables have on each other.

Approaches to technology

In this report technology is viewed as complex and varied, not only in how it evolves, but in how it is applied to societal problems and goals. The broad scope of technology is exemplified by descriptions of its different forms, such as "hard" or "soft," and "high" or "low." It can be a process (soft technology) such as research and the development of new knowledge, or products (hard technology) such as sophisticated new medical instruments and surgical procedures—which are also high technology—or simple in-home assistive devices and gadgets, which are low technology. Technology can, for example, be manifested in the ways in which health services are organized or new implements and devices created and utilized.[1] In this report, the term technology encompasses each of these levels, types, and applications of knowledge to solving problems and accomplishing tasks.

The relationship between technological change and the welfare of society involves decisions about what in fact constitutes a problem.[2] Because these decisions include judgments about what is "good," the development of knowledge and its technological applications not only *arise* from cultural values but are *themselves* social institutions. Modern technology surpasses that of earlier periods in its power, scope, and pace of change. Its societal consequences are thus becoming both more profound and more pervasive, intensifying the importance of understanding and anticipating technological impact and change.

Aging and technology

The interaction between technology and society presents both opportunities and challenges to individuals and social institutions. Will technological change enhance the ability of older persons to work or to perform daily activities of living, or will it instead limit their capacity to be self-sufficient? The rapid growth in numbers of older Americans is focusing increased attention on the social and economic costs or benefits of technology for the elderly, and for society as a whole.

New types of housing units and their design may minimize or exacerbate the difficulties faced by older individuals who are functionally impaired. Improved biomedical technologies to treat acute illnesses will present new questions about the value of life and the choices made about living and dying. Advances in health care that reduce the incidence of chronic disease are likely to require decisions about allocation of resources and whether access to health care services is a right or a privilege. The list of relevant issues is long and complex, but it is clear that none of these changes is independent of the others.

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[1] Another view is provided by physician and educator Lewis Thomas, who has proposed a three-level paradigm of technology: 1) nontechnology, such as personal supportive care services for dependent persons; 2) halfway technology, such as devices that compensate for disabilities (e.g., hearing aids, pacemakers, wheelchairs); and 3) decisive technology, such as basic research and science.

[2] In discussing the cultural aspects of technology and its use in solving problems, economist John Galbraith defined technology as the "systematic application of scientific or other organized knowledge to practical tasks" (8).

During this century, the application of technologies in the workplace, the home, the hospital, and the environment has led to great improvements in life expectancy and health across all age groups, particularly the youngest. Most recently, medical and other technologies have accelerated the improvement of life expectancy among the oldest age groups. Technological developments have also improved contraceptive efficiency, contributing to the notably low birth rates of the 1970s. The annual fertility rate of American women aged 15 to 44 was lower during the last decade than in any previous period.[3]

In combination, these changes in fertility and mortality will hasten the aging[4] of the American population during the next few decades. During the last 20 years the population aged 65 and over has grown twice as fast as the population under 65. The pace of technological change accelerated dramatically during this period, raising innumerable questions about the interaction of technology with the growing older population.

This assessment recognizes that technology involves the development of knowledge and its application to issues of aging in a variety of contexts, such as:

- *the biology or chemistry laboratory,* where new biotechnologies may enhance understanding of cellular aging and disease processes;
- *the health care setting,* where new diagnostic and treatment methods may prolong increasing numbers of lives;
- *the workplace,* where efficiency and productivity are new challenges for adult workers and for policymakers concerned with their physical, economic, and psychological well-being;
- *the home,* where functional independence is likely to be enhanced by new devices, information technologies, and differently organized long-term care service delivery systems; and
- *the community,* where public services, transportation systems, information technologies, and long-term care programs may enhance functional ability, or promote disease prevention, health promotion, and expanded options in daily living.

An examination of each of these broadly defined contexts led to the identification of issues that are of Federal concern in budgetary, regulatory, and oversight activities. Options that correspond to these issues, which will grow in importance as the elderly become a larger proportion of the U.S. population, are presented for congressional review.

Organization of the report

Major areas of concern

Four major areas were selected for attention in this assessment. Their importance, both direct and indirect, is evident in existing Federal policy, programs, regulations, and budgetary activities related to older Americans. These areas are:

- chronic conditions and biomedical research;
- functional impairment and long-term care;
- housing and the living environment; and
- employment and the workplace.

It should be noted that this assessment does not focus on acute illness and its treatment in the elderly, which would considerably expand its scope. Treatment of acute illness has already received extensive study, including other OTA assessments of medical technologies and acute health care.[5] **This assessment concentrates on chronic health conditions, biological factors, and**

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[3] Fertility rates measure the frequency of live births within a given population, such as "number of live births per 1,000 women aged 15 to 44." These rates do *not* account for stillbirths and aborted pregnancies, whether induced or spontaneous.

[4] The aging of the population means an increasing proportion of the total population in the older (over 65) relative to the younger (under 65) ages. It is also measured by median age, the age at which 50 percent of the population is older and 50 percent is younger.

[5] The OTA Health Program has published a series of case studies and technical memoranda on specific medical technologies for acute illness (22).

functional impairments of the elderly because of their growing significance to the independence of older persons and their ability to carry on various activities in the workplace, the home, and the community. Some of these areas are discussed in this chapter; many more are included in the chapters that follow.

The table of contents for this report indicates the breadth of subjects covered in the four general subject areas cited. Each chapter deals with the implications of technology and aging in a particular area. General themes include organization, financing, efficacy, regulation, safety, quality, education, and research. The congressional issues and options that conclude each chapter reflect many of these themes (e.g., the efficacy of medications for the elderly, the organization of long-term care, and the quality of housing and its design for the elderly). Areas for additional research are identified separately. Studies on the socioeconomic, attitudinal, behavioral, and other social scientific characteristics of the older population are not emphasized in the research priority sections unless they have a direct bearing on questions related to technological change.

Chapter topics were chosen in response to congressional requests and upon the advice of the project's Advisory Panel. The intent of this assessment is not to provide a comprehensive review of all aspects of technology and aging, but rather to examine the most important technological factors related to the physical and mental health status—and independence—of the older population.

Appendixes are included to provide detailed data and background information for several important areas, including morbidity and mortality, labor force participation, and biotechnology. The appendixes amplify information that is provided in the chapters.

The following section reviews the demographic phenomenon known as the aging of the American population. It discusses the changing characteristics of the older population and major trends in mortality and morbidity. Technological change and its relevance to these trends is assessed in relation to the report's four general subject areas, which give rise to key policy issues.

Where appropriate, the experiences of other Western industrialized countries with similar characteristics are cited as instructive models that may suggest possible policy options for the United States. Detailed comparisons of aging and public policy in these nations are, however, not included in this assessment.

Demographic background

Definitions

These definitions are central to discussion of the demographic aging of the American population and the future implications of current trends in U.S. population growth and change.

AGING AND THE AGED

For purposes of this report, the elderly are defined as all persons aged 65 and over (or "over 65"). Although 65 is a chronological definition of the onset of old age, there is no scientific "marker" of old age. In the United States and most Western industrialized countries, 65 years is the age of eligibility for full retirement income benefits. Some countries vary in this regard. In Japan the eligibility age for women is 55 and for men is 60; in Norway neither men nor women become eligible for full benefits until age 67. Age 65 was established as the eligibility age for full Social Security benefits at the U.S. retirement program's inception in 1935.[6]

It is important to note, however, that aging is a gradual biological process that differs among individuals; people do not suddenly "become old" at 65. **Indeed, the older population tends to be**

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[6] Age 65 has a historical basis; for example, it was used by Germany's Chancellor Bismarck in the late 19th century to establish eligibility for military pensions. Although the Chancellor lived past 80, one of his intentions appears to have been to limit the number of pension beneficiaries in an era when average life expectancy at birth was less than 45 years.

more, rather than less, heterogeneous in its social, political, economic, health, and other characteristics than those under 65. A chronologically based label is convenient for defining population groups, but is a poor descriptor of biological function or need for various types of assistance. Further ambiguity is seen in the different age criteria for the "elderly" in Federal programs and public statutes. Federal housing assistance programs for the elderly use age 62, while programs under the Older Americans Act are available to those 60 and over. The Internal Revenue Service allows an elderly credit on personal income taxes for Americans 65 and over, but the one-time capital gains allowance from the sale of a primary residence is available to anyone over 55. The Age Discrimination in Employment Act (ADEA) protects workers 40 and over, although no inference is made that workers in their 40s are "old." Thus, social values and policy-relevant definitions concerning old age vary widely, and often depend on the issues, programs, needs, and constituents involved.

"The aged" as a group must be distinguished from "aging" as a process that varies both in different species and across subgroups within the same species. The great variation in average life expectancies *across* species is illustrated by the fact that mice live an average of 3 years and humans an average of 74 years. There is growing evidence that aging and the incidence of diseases associated with age also vary *within* species. These differences are associated with genetic factors, biological differences, environmental influences, and, for humans, socioeconomic status. For example, average life expectancies at birth range from as low as 45 in some developing countries (Gambia, Niger, and Somalia) to as high as 76 in some developed countries (Norway, Sweden, and Japan). In the United States, the average life expectancy at birth for a white female (78.7 years) is almost 12 years greater than for a black male (66.5 years).[7]

Given these variations, definitions of "the elderly" based on chronological age are artificial. Individual variation within each age group is great. **Although it is convenient and often necessary to use chronological age (e.g., in formulating public policy), such boundaries must be used with caution when making inferences about the elderly as a group.** Both technology and aging can affect individuals or subgroups of the same chronological age differently, depending on such other factors as their functional capabilities and the social or environmental characteristics that influence their interaction with society.

Because the over-65 group is so heterogeneous, some segments of this report identify those between 65 and 74 as the *young-old* and those 75 and over as the *old-old*. When it is necessary to make still finer distinctions, persons over 85 are referred to as the *very old*. In certain policy-related issues, such as older workers' employment and the ADEA, the "elderly" can also include those 40 to 64; these exceptions to the report's basic definitions are noted as they occur.

The aging of a population is a gradual process in which the proportions of adults and elderly increase while the proportions of children and adolescents decrease. This results in a rise in the median age (i.e., the age at which 50 percent of the total population is older and 50 percent is younger). Aging occurs when fertility rates decline or remain constant, while mortality rates remain constant or improve, especially at the older ages.

COHORT V. PERIOD DATA

In discussing population aging and demographic trends, two main types of data can be utilized: period data and cohort data. Period, or "cross-sectional," data describe variables or events that occur across a population within a specified time period. Cohort data, by contrast, follow the experiences of a particular population group over a long time period. The major difference is that period data present a "snapshot" of different age groups in a short time period or at one point in time, while cohort data provide a "lifetime picture" of a particular group over many years (see fig. 5).

The most useful cohort in demography is the "birth cohort"—a group of individuals born within a certain time period, usually a calendar year or

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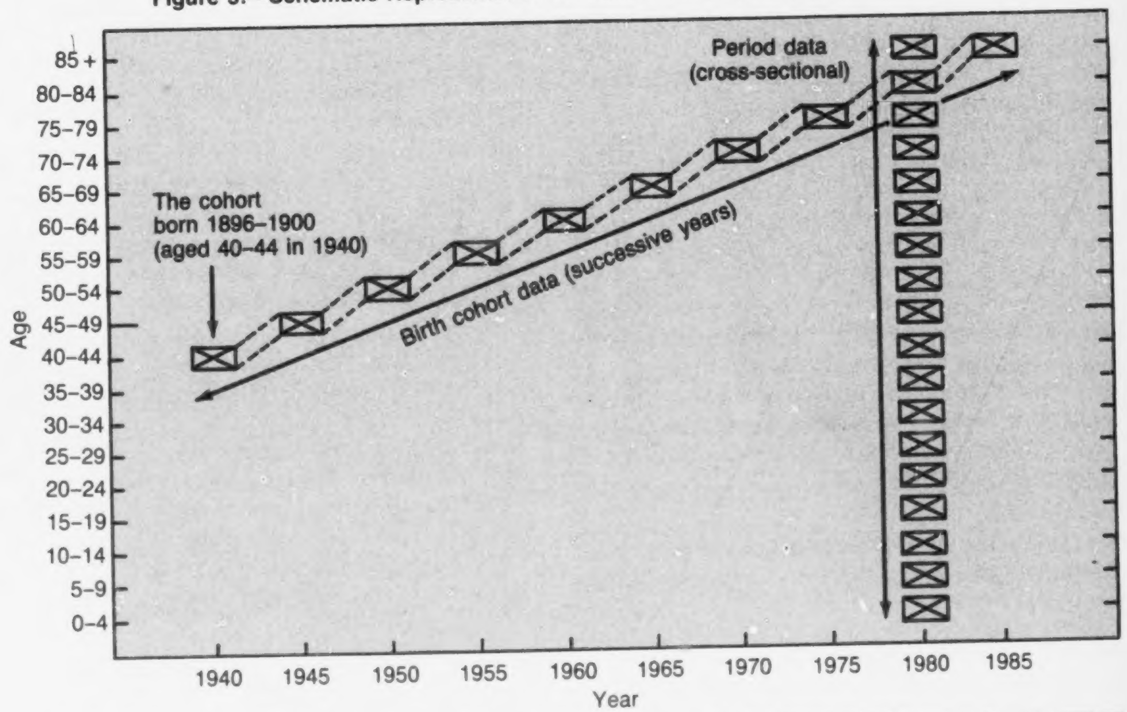
[7] Data on racial categories used in this report are technically differentiated as "white" or "black and other." For convenience, "black" is used in the text, rather than "black and other."

Figure 5.—Schematic Representation of Cohort Data and Period Data



NOTE: Birth cohort data describe the events experienced over time by a group born in the same year(s), i.e., as the group "ages"; period data describe the events across age groups at one point in time.

SOURCE: Office of Technology Assessment.

a 5-year interval.[8] The experiences of this birth cohort can be "followed" through its lifetime. Each birth cohort experiences a set of events over time that is characteristic of its aging and the historical period during which this aging occurs, the consequences of which are called "cohort effects."

Cohort analysis is important in gerontological study because it measures change within a group over time, as in panel or longitudinal studies. Because actual birth cohort data are not readily available for long time periods, age-specific cross-sectional data over many years are often used to *approximate* the cohort experience. But they do not provide comparable information.

Most events in a population are influenced by both cohort and period effects. For example, the educational attainment of the elderly in 1980 is largely a result of the educational attainment of the pre-1915 birth cohorts during their "school-age years." Successive birth cohorts had higher levels of education (a period effect). As the cohorts aged and became part of the future elderly population, the average level of the total older population's educational attainment increased. **In this way, earlier period effects are combined with the aging of the birth cohorts to yield new cross-sectional data at a later time.** For example, from 1970 to 1980 the proportion of persons over 65 who had completed 1 or more years of high school increased sharply from 30 to more than 50 percent. This large change was primarily due to the cohort effect of a more highly educated group aged 55 to 64 who had entered the over-65 category by 1980.[9]

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[8] For example, persons aged 64 in 1984 belong to the 1920 birth cohort. A birth cohort can also be defined for a longer period of time. For example, the 1915-19 birth cohort was aged 61 to 65 in 1980.

[9] The difference between cohort and period effects is illustrated by more detailed comparison of the data on educational attainment. In 1970 only 30 percent of all persons over 65 had completed 1

For certain analyses, cross-sectional and cohort data are combined to create "synthetic cohorts," which are hypothetical groups that substitute for real birth cohorts. A synthetic cohort is created by using cross-sectional demographic data and applying them to a birth cohort over its future lifetime. These hypothetical cohorts are the basis for the most commonly used life expectancy tables. Synthetic cohorts are essential because a real cohort's mortality experience requires observations dating back 100 years, and such data are not generally available. The fertility and mortality characteristics of synthetic cohorts are the basis for most population projections developed by Federal agencies. The role of these characteristics in creating synthetic cohorts is an important factor in evaluating projections of the future elderly population.

Demographic projections of the elderly population

The two major U.S. national population projections are provided by the Bureau of the Census and by the Social Security Administration (SSA). The SSA projections are primarily used for future planning of the Social Security system and its long-term financing obligations. The Census Bureau projections include all age, sex, and race subgroups of the total population and are the most commonly used population forecasts. The word "forecast" is used intentionally to emphasize that demographic projections are *not* predictions.

Projections are developed in three "series" that differ according to the basic demographic assumptions used to create the synthetic cohorts that form the "new" populations. The three series use low, middle, and high estimates of each type of age-specific vital rate for 1-year birth cohorts (called the cohort component method[10]).

The accuracy of demographic projections has improved during the last few decades with the application of more sophisticated methodologies. The most recent projections use the latest population base from the final counts of the 1980 census, revised by estimates of the population as of July 1, 1981 (see table 1). In general, the middle-series assumptions are considered the most likely to occur, and the low and high assumptions define a reasonable rate of error around the middle series. Each of these components will vary from expectations because of unpredictable cultural, economic, and biological factors.

The least predictive component is fertility, which is most likely to be influenced by exogenous factors (e.g., economic conditions, government policy), to be controlled by personal choice, and to be influenced by the adequacy of contraceptive methods. The "baby boom" following World War II was not projected for the 1945-60 period, either in terms of the birth rate or the number of years during which fertility remained high. Nor was the precipitous decline in fertility since the early 1960s expected. Both of these fertility trends have an impact on the short- and long-term changes in the aging of the population.

Mortality is less difficult to estimate, barring no *major* short-term deviations in age-, race-, and sex-specific trends in death rates. However, recent changes in health and medical care technologies have added an element of uncertainty to age-specific mortality rates for cohort projections. Assumptions about changes in age-specific death rates have been lower than reality in most projections during the past 30 years (19). The unprecedented increases in life expectancy at the *oldest*

(continued from p. 37)

or more years of high school, compared with 55 percent of those 25 to 64. By 1980, the survivors of the 1970 cohort of persons over 65 had become the over-75 group. In 1980, 28 percent of those over 75 had 1 or more years of high school. Because most persons do not add to their formal education after age 30—much less after age 65—the educational level of this elderly cohort did not change as it aged during the 1970-80 decade. The cohort effect produced a slight decrease in 1980 in the proportion of those over 65 with 1 or more years of high school (probably due to bias in educational level of the cohort survivors or a statistical artifact).

Period (i.e., cross-sectional) data provide different information. By 1980 more than 50 percent of all persons over 65 had completed 1 or more years of high school, an increase of 20 percentage points for that age group between 1970 and 1980. The major reason for this increase in the *period* rate was the movement of the cohort aged 55 to 64 in 1970 into the over-65 category in 1980. The younger age group brought with it notably higher educational attainment levels, thereby increasing the average for the new over-65 group in 1980 (i.e., not the same birth cohort).

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[10] The "cohort component method" separately projects age-specific fertility, mortality, and immigration rates for each 1-year birth cohort, using the three alternative levels of each demographic component. These "scenarios" are then played out over the remaining lifetime of each birth cohort to yield the projections for future decades.

Table 1.—Growth of the Population Aged 55 and Over, by Selected Age Groups, 1900-2050 (numbers in thousands)

Year	Total population, all ages		55 years and over		55 to 64 years		65 to 74 years		75 to 84 years		85 years and over		65 years and over	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1900	76,303	100%	7,093	9.3%	4,009	5.3%	2,189	2.9%	772	1.0%	123	0.2%	3,084	4.0%
1910	91,972	100	9,004	9.8	5,054	5.5	2,793	3.0	989	1.1	167	0.2	3,950	4.3
1920	105,711	100	11,465	10.8	6,532	6.2	3,464	3.3	1,259	1.2	210	0.2	4,933	4.7
1930	122,775	100	15,031	12.2	8,397	6.8	4,721	3.8	1,641	1.3	272	0.2	6,634	5.4
1940	131,669	100	19,591	14.9	10,572	8.0	6,375	4.8	2,278	1.7	365	0.3	9,019	6.8
1950	150,697	100	25,565	17.0	13,295	8.8	8,415	5.6	3,278	2.2	577	0.4	12,270	8.1
1960	179,323	100	32,132	17.9	15,572	8.7	10,997	6.1	4,633	2.6	929	0.5	16,560	9.2
1970	203,302	100	38,588	19.0	18,608	9.2	12,447	6.1	6,124	3.0	1,409	0.7	19,980	9.8
1980	226,505	100	47,244	20.9	21,700	9.6	15,578	6.9	7,727	3.4	2,240	1.0	25,544	11.3
1990	249,731	100	52,889	21.2	21,090	8.4	18,054	7.2	10,284	4.1	3,461	1.4	31,799	12.7
2000	267,990	100	58,815	21.9	23,779	8.9	17,693	6.6	12,207	4.6	5,136	1.9	35,036	13.1
2010	283,141	100	74,097	26.2	34,828	12.3	20,279	7.2	12,172	4.3	6,818	2.4	39,269	13.9
2020	296,339	100	91,629	30.9	40,243	13.6	29,769	10.0	14,280	4.8	7,337	2.5	51,386	17.3
2030	304,330	100	98,310	32.3	33,965	11.2	34,416	11.3	21,128	6.9	8,801	2.9	64,345	21.1
2040	307,952	100	101,307	32.9	34,664	11.3	29,168	9.5	24,529	8.0	12,946	4.2	66,643	21.6
2050	308,856	100	104,337	33.8	37,276	12.1	30,022	9.7	20,976	6.8	16,063	5.2	67,061	21.7

SOURCES: U.S. Bureau of the Census, "America in Transition: An Aging Society," *Current Population Reports*, Series P-23, No. 128, September 1983; base data from U.S. Bureau of the Census, *Decennial Censuses of Population, 1900-1980* and Projections of the Population of the United States: 1982 to 2050 (Advance Report), *Current Population Reports*, Series P-25, No. 922, October 1982. Projections are based on middle-series assumptions.

ages during the 1970s were not anticipated in projections during that time.[11]

Net immigration figures tend to be most easily estimated, given the relationship of immigration rates to Federal policy, quotas, and registration procedures. However, immigration rate assumptions do not take account of the high annual total of undocumented immigrants who enter the United States. Estimates of their numbers vary greatly because no accurate data are available.

These factors illustrate the need for caution in the use and interpretation of population projections. The longer the interval covered by a projection, the greater the degree of uncertainty and error in the estimates. Each successive year following the decennial census compounds the inaccuracy of the estimates for the basic populations in the projections. **Projections of the *numbers* of older people are more reliable than those that yield percentage figures; percentages depend on the number of persons in *every* other age group, which depend largely on fertility trends over time (the least predictable variable for projections).**

Projections of elderly *households* are even less reliable, because household formation and size are influenced by factors such as marital status, income, health, extended family structure, tax policy, and other variables that are themselves difficult to project. A final source of potential inaccuracy in projections is the base population (or baseline data) from which future cohorts are developed. As shown in chapter 9, for example, the 1979 estimates of tenure (i.e., owners v. renters) for elderly households were very different from the totals enumerated by the 1980 census.[12]

Taking these caveats into consideration, the following section reviews the demographic trends that have had the greatest influence on the aging of the U.S. population, and looks at current projections of the older population.

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[11] Projections based on the increased rates of decline in age-specific mortality rates for the older population subgroups (by age, race, and sex) during the 1968-77 period yield a total older population in 2000 that is almost 4 million persons *more* than was officially projected by the Census Bureau in 1977—an underestimate of more than 10 percent. The most recent official projections have been adjusted upward to account for this dramatic change.

[12] New household projections based on 1980 census counts have not been officially generated; because the most recent official projections use 1978 estimates from the Current Population Survey, the potential for error remains strong.

Demographic trends

Among the population changes experienced by the United States during this century has been unprecedented growth in the number and proportion of older Americans. Demographic aging, its changing pace, and the technological factors that have both created it and responded to it point to substantial challenges and opportunities for American society. Improved understanding of these trends is important in enabling both the public and private sectors to anticipate and thus respond appropriately to the needs of future cohorts of elders and to benefit from the resources they possess.

The most significant demographic trends are:

- rapid growth of the over-65 population during most of this century and its continued high rate of growth during the next 50 years (the aging of the baby boom generation, resulting in the "elderly boom" during 2010 to 2025);
- changes in life expectancy at birth and at the older ages, especially the most recent increases in the rate of improvement for the very old; and
- aging of the older population itself, with the fastest rates of growth among the oldest subgroups (sometimes referred to as an "aging implosion").

The growth of the older population

In 1900 only 4 percent of the total U.S. population was over 65. By 1980 this proportion had risen to 11.2 percent and the number of older Americans exceeded 25 million (see table 1). In

1983 the elderly population was estimated to have surpassed 27 million, and to account for 11.6 percent of the total. The growing proportion of older persons has boosted the median age significantly in less than three generations—from just under 23 years in 1900 to over 30 by 1980.

This growth in the number and proportion of the elderly is expected to continue, but at a slower pace, through the end of the century. The most recent projections indicate that the ranks of the elderly will increase by at least 30 percent by the year 2000, when they will constitute more than 13 percent of the total population. By recent standards, this projected growth is relatively small, due largely to the effect of the small birth cohorts and relatively high infant mortality rates during the Depression and World War II period of 1925-45. Both of these factors will limit the number of older persons in future decades (when net immigration is held constant).

The effect of the baby boom birth cohorts on the future older population will be felt after 2010, when America's elderly boom begins. By 2020, the elderly population is expected to exceed 51 million and to account for more than 17 percent of the Nation's population.[13] **The projected increase in numbers of older Americans between 2010 and 2020—more than 12 million—is only slightly less than the number of those expected to join the over-65 population during the *entire* 30-year period from 1980 to 2010** (see table 1).

Changes in average life expectancy

During most of this century, gains in the life expectancy of Americans have occurred because of improvements in public sanitation, hygiene, control of infectious diseases, prenatal maternal and postnatal infant care, and, since the 1940s, antibiotics. These improvements have sharply reduced infant mortality, which began to fall in the early 1930s, resulting in higher survival ratios for successive birth cohorts.

Only 41 percent of infants born in 1900 survived to reach age 65; by 1980 this proportion had risen to more than three-fourths.[14] In 1900, average life expectancy at birth was 47.3 years; those who reached 65 could expect to live another 11.9 years. By 1983, average life expectancy at birth had increased by more than 27 years—to 74.7. **The change in life expectancy at age 65, however, has been far less impressive for most of this century. In 1983 this figure was just 16.8 years, on average, for those aged 65—an increase of only 4.9 years since 1900.**

More notable is the *recency* of the increase in life expectancy at older ages. The average life expectancy of those aged 65 in 1950 was 13.9 years—only 2 years higher than in 1900, reflecting an improvement of only 17 percent during the entire half-century (see table 2). Since 1950, however, the corresponding figure has already risen by 2.9 years (to 16.8 for 1983), a 20-percent improvement in just 33 years. Yet this dramatic improvement in old age survivorship masks still more recent advances in age-specific mortality. **Of the 2.9 years gained since 1950, 1.6 years were added between 1970 and 1983. This increase is the largest change ever recorded in life expectancy at age 65 in such a short period of time—more than one-half of the total gain since 1950 occurred in the last 13 years of this 33-year period.**

The aging of the older population

This improvement occurred at the same time that the older population *itself* was aging, most notably since 1960. The growth of the very old population coincides with improvements in medical technologies, especially lifesaving measures in acute care (e.g., coronary bypass surgery and cardiac pacemakers) and life-sustaining technologies (e.g., diagnosis and treatment of hypertension). The survival of increasing proportions to the very old ages also coincides with the establishment of the Medicare program, which gave older people greater access to medical technology.

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[13] These projected figures are based on the most recent middle-series assumptions: 1.9 total births per woman by 1985 and constant thereafter; life expectancy at birth increasing to almost 80 years for whites by 2050 and for blacks by 2080; and net annual immigration of 450,000 persons.

[14] Infant mortality has dropped sharply from 56 deaths per 1,000 live births of infants under 1 year of age in 1935 to a rate of about 11 in 1982 (24).

Table 2.—Life Expectancy at Birth and at Age 65, by Race and Sex, United States, Selected Years, 1900–82
(average number of years remaining)

	Total			White			Black and other		
Age and year	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
At birth:									
1900	47.3	46.3	48.3	47.6	46.6	48.7	33.0	32.5	33.5
1950	68.2	65.6	71.7	69.1	66.5	72.2	60.8	59.1	62.9
1960	69.7	66.6	73.1	70.6	67.4	74.1	63.6	61.1	66.3
1970	70.8	67.1	74.7	71.7	68.0	75.6	65.3	51.3	69.4
1980	73.7	70.0	77.5	74.4	70.7	78.1	69.5	65.3	73.6
1981	74.1	70.3	77.9	74.7	71.0	78.5	70.3	66.1	74.5
1982	74.5	70.8	78.2	75.1	71.4	78.7	70.9	66.5	75.2
At age 65:									
1900	11.9	11.5	12.2	—	11.5	12.2	—	10.4	11.4
1950	13.9	12.8	15.0	—	12.8	15.1	—	12.5	14.5
1960	14.3	12.8	15.8	14.4	12.9	15.9	13.9	12.7	15.2
1970	15.2	13.1	17.0	15.2	13.1	17.1	14.9	13.2	16.4
1980	16.4	14.1	18.3	16.5	14.2	18.5	15.5	13.5	17.3
1981	16.7	—	—	—	—	—	—	—	—
1982	16.8	—	—	—	—	—	—	—	—

SOURCES: National Center for Health Statistics, *Health: United States, 1982*, DHHS publication No. (PHS) 83-1232, Public Health Service (Washington, DC: U.S. Government Printing Office, 1982); and "Annual Summary of Births, Deaths, Marriages, and Divorces: United States, 1982," *Monthly Vital Statistics Report* 31:13, DHHS publication No. 83-1120 (October 1983) and 32:4, DHHS publication Supplement No. 83-1120 (Hyattsville, MD: Public Health Service, August 1983).

Table 3 shows the increasing proportion of those over 85 in the total older population since 1960 and the expected growth of the very old population through 2020. In 1960 about 1 in 20 older persons was over 85; by 1980 that proportion had grown to 1 in 11 (8.8 percent). During the same period the proportion aged 65 to 74 fell from 66 to 61 percent of the total. Because of the small birth cohorts during the 1926-35 Depression period, the 65 to 74 group is expected to be just one-half of the total older population at the turn of the century, while those 75 to 84 are likely to constitute more than one-third of all elderly persons, and those over 85 to reach their highest proportion, close to 15 percent.

Despite the possibility of small errors in these projections, the "implosion," or aging of the older population itself, promises to be as important as the sheer growth in total number of older persons. The positive and negative impacts on society of the growth of this aging elderly population, brought about in large part by increasingly rapid technological change during the last half-century, will inevitably spawn additional new technologies.

The dimensions of this dramatic transformation and its implications for society are not easily comprehended. Recent changes in the age composition of the older population tend to obscure the

Table 3.—Relative Distribution of the Population Aged 65 and Over, by Selected Age Groups, Selected Years, 1960–2020[a]

	Population age 65 and over		Percent distribution by age group		
Year	Number (in millions)	Percent	65–74	75–84	85 and over
1960	16.6	100%	66.4%	28.0%	5.6%
1980	25.5	100	61.0	30.2	8.8
2000	35.1	100	50.5	34.8	14.7
2020	51.4	100	57.9	27.8	14.3

[a] Projections for years 2000 and 2020 are based on middle-series assumptions.

SOURCE: U.S. Bureau of the Census, Projections of the Population of the United States: 1982-2050 (Advance Report), *Current Population Reports*, Series P-25, No. 922, October 1982.

actual improvement in elderly survivorship when data are reported for the older population as a whole. This problem is avoided by using age-specific, as well as age-adjusted, death rates.[15]

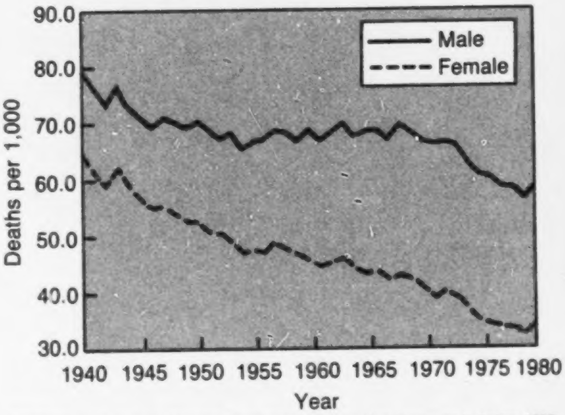
From 1940 to 1978 the age-adjusted death rate for the elderly decreased by more than 37 percent—11 percent *more* than indicated by unadjusted rates for the same period. Similarly, age-adjusted death rates for older women and men decreased by greater proportions than indicated by the overall rate (5). These age-adjusted declines in mortality among the older age groups for both sexes are primarily due to the improved technologies that have contributed to the growth of the very old population.

When plotted on an annual basis, elderly death rates for the 1955-67 period form a plateau, with relatively little change in real mortality rates (i.e, age-adjusted) in the older population. **But during the 1968-80 period, sharp reductions in elderly mortality rates occurred.** Average *annual* reductions in age-adjusted death rates for this period were 1.5 percent for older males and 2.1 percent for older females. The nature of this recent trend in real mortality decreases among the elderly is shown in figure 6. **The post-1967 mortality declines among the elderly have been greater than for any previous period in American history, and suggest a new era characterized by continued decreases in age-adjusted elderly death rates during the rest of the century** (see also table 4).

Trends in life expectancy by sex and race

Figure 7 shows that *sex* differences in age-specific life expectancy have become increasingly greater than *racial* differences since the 1930s. **Life expectancy at birth for women has increased far more rapidly than for men; the most dramatic improvements have been for black women, whose life expectancy at birth surpassed that of white men for the first time in 1967.** This demographic change began at the turn of the century, when female survivorship rates started to improve more rapidly than male survivorship rates. In 1900 life expectancy at birth was distinguished by a great disparity between blacks and whites, rather than between the sexes, as shown in figure 7. By the 1930s the life expectancy of black women clearly began to accelerate relative to that of men of both races. By 1980 black women's life expectancy approached that of white women, who have the highest level. As a whole, newborn girls can now expect to live, on average, 8 years longer than newborn boys.[16]

Figure 6.—Age-Adjusted Death Rates for the Population Aged 65 and Over, by Sex, United States, 1940-80



SOURCE: U.S. Senate, Special Committee on Aging, *Developments in Aging: 1983, Volume 1*, Washington, DC, Feb. 29, 1984. Based on unpublished tabulations by L. Fingerhut, National Center for Health Statistics.

This life expectancy difference by sex is consistent with the rates in many industrialized countries, particularly those of Northern Europe. Average life expectancies at birth in Denmark,

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[15] Age-adjusted demographic rates provide true indicators of age-specific change, because they control for the effects of changes in population age composition that can have a biasing effect on vital rate data over time. The age-adjusted rates for two or more points in time are directly comparable, because they indicate what the rates *would* be if the populations had the same age composition at those points in time. Measures using age-adjusted rates in demography are the same as measures using "constant dollars" in economic research. The "base year" for age-adjusted rates is usually 30 to 40 years earlier in order to show a definite trend over time.

[16] Note that life expectancy figures are derived from life table calculations that utilize age-specific *period* death rates by race and sex. The life table "population" begins with a synthetic (or hypothetical) birth cohort whose mortality experience over its entire "future lifetime" is based on *current* age-, sex-, and race-specific death rates. It is possible that these rates for the synthetic cohort overestimate the mortality experience of the real birth cohort as it ages during the next 85 years, thus *underestimating* actual improvements in future life expectancy.

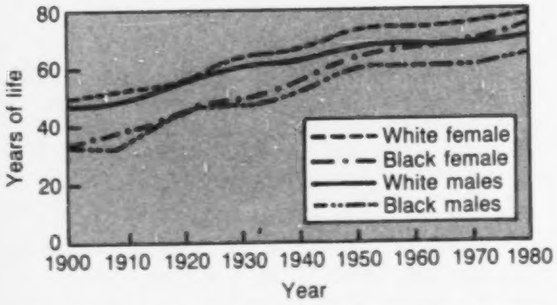
Table 4.—Average Annual Percent Change in Age-Adjusted Death Rates for Persons Aged 65 and Over, by Sex and Age, United States, Selected Periods of Years, 1940-80

	Years		
Sex and Age	1940-54	1955-67	1968-80
Males:			
Age 65 and over[a]	−1.1%	0.2%	−1.7%
65-69	−0.7	0.1	−2.1
70-74	−1.0	0.2	−1.6
75-79	−1.1	0.2	−1.7
80-84	−1.3	−0.4	−1.3
85 and over	−1.5	0.9	−1.4
Females:			
Age 65 and over[a]	−2.0	−1.0	−2.3
65-69	−2.3	−1.1	−2.3
70-74	−2.2	−1.3	−2.1
75-79	−1.9	−1.2	−2.6
80-84	−1.9	−1.1	−2.3
85 and over	−1.3	0.0	−2.1

[a] Age adjusted to the United States population aged 65 and over as of 1940.

SOURCE: National Center for Health Statistics, "Changes in Mortality Among the Elderly: United States, 1940-78," *Supplement to 1980: Vital and Health Statistics*, Series 3, No. 229, DHHS publication No. (PHS) 84-1406a, Public Health Service (Washington, DC: U.S. Government Printing Office, 1984).

Figure 7.—Average Life Expectancy at Birth, by Race and Sex, United States, 1900-80



SOURCE: National Center for Health Statistics, *Vital Statistics of the United States, 1980: Life Tables*, vol. II, sec 6, DHHS publication No. (PHS) 84-1104 (Hyattsville, MD: Public Health Service, May 1984).

Sweden, Norway, the Netherlands, and other European countries are slightly *higher* (by 1.0 to 1.5 years) than in the United States, and have similar differences in life expectancies by gender. But most of these industrialized countries have life expectancies at age 65—both average and for men and women—that are either equal to or slightly *below* those of the United States. This anomaly is partly explained by the older age structure of most of these European countries relative to that of the United States, as measured by median age or by the proportion of the total population over 75.[17] **The sex differences in life expectancy at birth suggest that the United States can expect continued discrepancy between the survival ratios of men and women, even as the proportion of older women increases in future years.**

The sex- and race-specific changes in life expectancy during the last half-century have greatly affected the composition of the older population. **By 1983 there were over 5 million more women than men over 65, a ratio of 3 older women to every 2 older men.** As recently as 1960 this ratio was 5 to 4. This discrepancy increases notably for the very old; **among those over 85 there are almost 5 women for every 2 men (42 men for every 100 women).** There are no indications that this general pattern will change for the ensuing decades into the 21st century.

Yet the *rate* at which women's life expectancy at birth and, in particular, at age 65 increases relative to that for men is not expected to grow at the same pace that it has for the last four decades (14). As shown in table 2 and figure 8, the 1970-80 increases in life expectancy at age 65 have been only slightly lower for white men than for white women, while slightly *higher* for black men. In general, older men and women are now benefiting similarly from the recent decreases in death rates from most causes of mortality, but the large sex differentials in life expectancy at birth and at age 65 remain.

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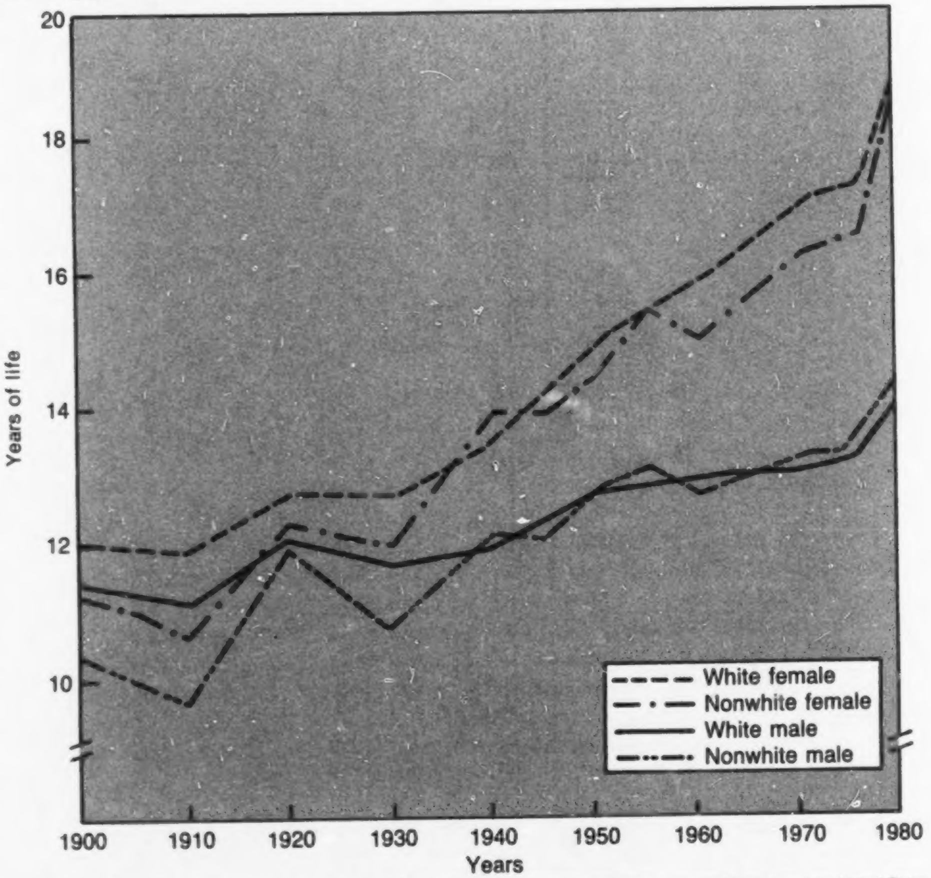
[17] The proportions of persons over 75 in most Northern European countries range from 0.5 to 2.3 percent higher than in the United States, a demographically large difference. Higher age-specific death rates at the oldest ages partly explain the similarity in life expectancy at age 65 between these countries and the United States. But higher life expectancies at birth, despite the older age structures, indicate that both female and male life expectancies at ages under 65 are usually higher than in the United States.

These trends in age-specific mortality for both sexes indicate that more people will not only be living to older ages, but will also be living considerably longer after age 65 than ever before in the United States. A visual image of how the demographic structure of the U.S. population is expected to change emphasizes the potential impact of these trends. Although not directly representative of the most recent projections from which table 1 was developed, figure 9 presents a recent set of population pyramids[15] based on projections made in 1980. The baseline data for the projections assumed higher total fertility rates, lower

Figure 8.—Average Life Expectancy at Age 65, by Race and Sex, United States, 1900–80



SOURCE: Office of Technology Assessment, based on data from the National Center for Health Statistics, *Vital Statistics of the United States, 1980: Life Tables*, vol. II, sec. 6. DHHS pub. No. (PHS) 84-1104 (Hyattsville, MD: Public Health Service, May 1984).

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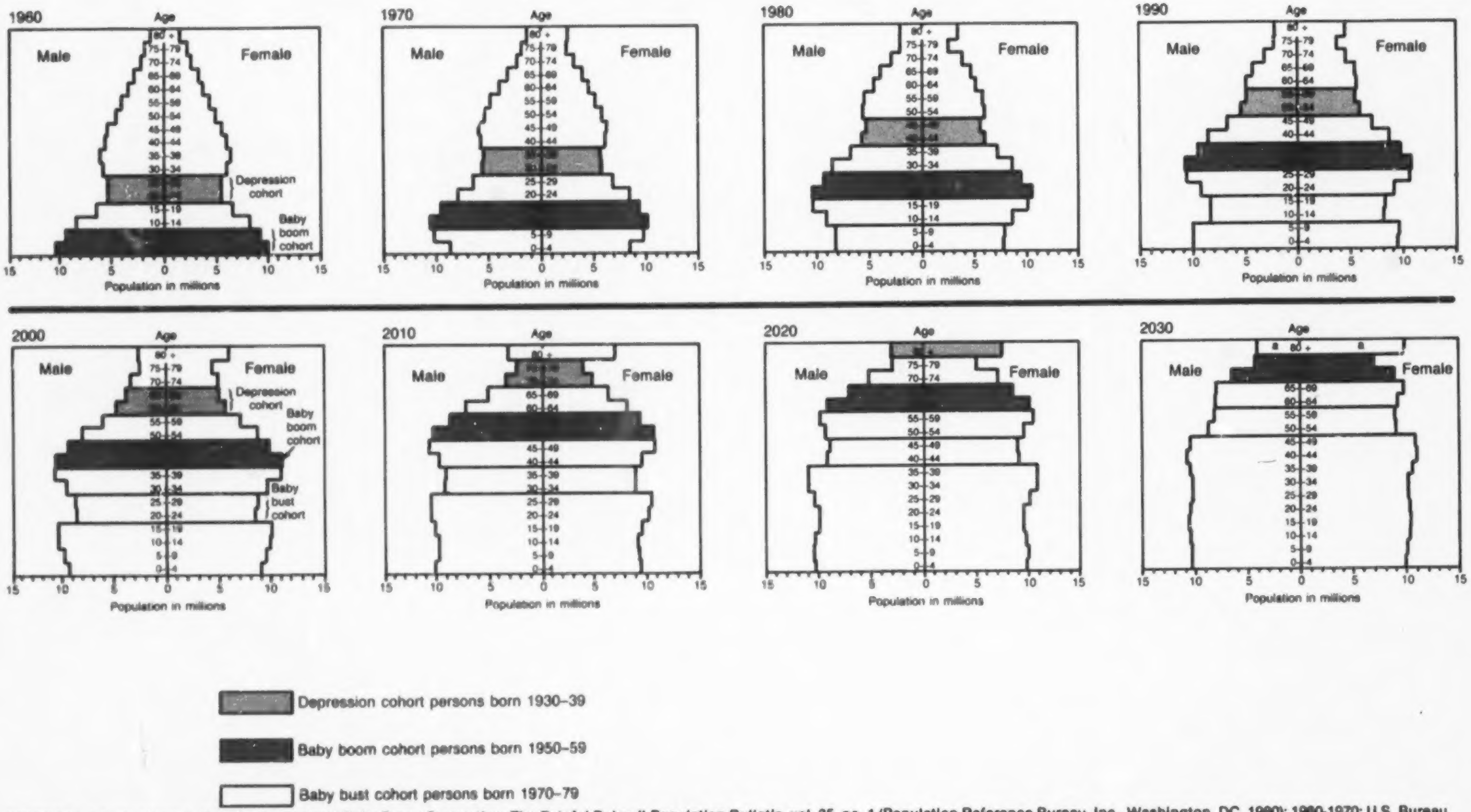
[15] Population pyramids are graphic representations of the sex and age composition of a population, using either 1- or 5-year age intervals for each sex to age 85 and over. The diagram is called a pyramid because the structure of most populations in earlier periods closely resembled the tapering form of a pyramid, with decreasing numbers and proportions in successively older age groups. The measure used for the horizontal axis can be either absolute numbers, as in fig. 9, or percentages of the total.

Figure 9.—Population Pyramids, by Age and Sex, United States, 1960–2030



SOURCES: Adapted from L. Bouvier, "America's Baby Boom Generation: The Fateful Bulge," *Population Bulletin*, vol. 35, no. 1 (Population Reference Bureau, Inc., Washington, DC, 1980); 1960-1970: U.S. Bureau of the Census, *1970 U.S. Census of Population: General Population Characteristics, United States Summary*, vol. 1, PC(1)-B1, 1972, Table 52; and 1980-2050: Special unpublished tabulations prepared by L. Bouvier for the Select Commission on Immigration and Refugee Policy, 1980.

NOTE: 1980-2050 projections assume a total fertility rate rising to 2.0 births per woman by 1985 and constant thereafter; life expectancy at birth rising to 72.8 years for males and 82.9 years for females by 2050; net immigration constant at 750,000 persons per year.

ultimate life expectancies, and higher levels of net immigration than more recent projections. The aging of the populations in these pyramids, as depicted by the degree to which they become "squared" in ensuing decades, is *less* than the most recent projections would anticipate. They therefore reflect the *minimum* aging that is expected to occur in the U.S. population structure during the next 50 years.

The "wave" of the large baby boom cohort in 1960 (ages 0 to 9 in the pyramid) continues to exert its influence as it ages into the years 2010-30. The squaring of the population's structure is accompanied by the rapid rate of growth in numbers of older women in successive decades. Even if mortality rate reductions at the older ages become similar for *both* sexes in ensuing years, the current higher survival ratios of women over 55, who presently outnumber men in this age group by almost 7 million, will produce higher numbers of surviving women for at least the next 30 to 40 years.

Major causes of death in old age

Dramatic percentage decreases in death rates have been occurring in all older age subgroups, as shown in table 4. Indeed, persons reaching 85 can expect to live, on average, beyond 92. As is true of mortality declines for the elderly in general, the major contributor to these decreases in death rates of the very old has been the age-specific decline in cardiovascular deaths. As has been noted, there is no clear evidence to explain these dramatic improvements among all older age groups, but the most likely factors include:

- recent technological advances in the care of acute illnesses that might otherwise have led to death;
- improved monitoring and control of risk factors such as high saturated fat and cholesterol diets, cigarette smoking, and hypertension; and
- changes in long-term care of the chronically impaired, both in institutions and in the community.

Underlying these newly emerging improvements in life expectancy at the older ages are recent declines in age-specific mortality from acute episodes of infectious diseases (e.g., pneumonia and influenza) and the major chronic diseases, especially diseases of the heart and cerebrovascular diseases (stroke). The latter two disease categories, plus malignant neoplasms (cancers), currently account for three out of every four deaths among the elderly,[19] an overall proportion that has remained unchanged since World War II. However, the *relative* proportion of deaths from each of the three leading causes of elderly mortality has changed over the last 30 years, in part explaining the recent improvements in life expectancy at older ages.

HEART DISEASE MORTALITY

Coronary heart disease remains the Nation's leading cause of death, both among the elderly and in the total population. Although 46 percent of all deaths among persons over 65 in 1980 were due to cardiovascular diseases, age-specific death rates from these causes have steadily declined among the elderly during the past three decades, particularly since 1970. **Between 1970 and 1979, the death rate from heart disease for persons 65 to 74 declined 22.7 percent—the most substantial decrease ever recorded in a decade for this disease category and this age group.** For those 75 to 84, the decrease was 14.5 percent; the over-85 age group had an 18.7-percent decrease during this same period. The relative risk of death from heart disease increases with age, even among the elderly. In 1980, heart disease accounted for less than 41 percent of deaths for persons 65 to 74, but almost 49 percent of deaths among those over 85.

The variations in heart disease mortality within these age groups by race and sex are noted in appendix A. In general, proportional improvements have been highest for women and blacks, except for increases among blacks 75 to 84.

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[19] "Cause of death" data utilized by the National Center for Health Statistics (NCHS) are based on information contained in death certificates. In general, the cause of death in NCHS tabulations reflects the *underlying* cause or event that led to death. This cause may differ from the "immediate" cause of death that is reported on the death certificate (e.g., a death from a skull fracture due to an automobile accident would usually be reported as due to the accident rather than the skull fracture). In 1978 nearly 75 percent of all death certificates listed more than one condition and 15 percent had four or more. Cause of death data generally indicate the underlying condition, but not the complicating ones that may have contributed to the death (23).

There are no definitive explanations for the heart disease mortality differences within or between the racial groups. Similar differences are also seen in other causes of death and in morbidity rates. Some gerontological studies show that elderly blacks face the "double jeopardy" of old age and minority status; the problems of aging are compounded for minorities by lifelong confrontations with lower social, economic, psychological, and physical health status. These disadvantages are reflected in their greater incidence of chronic and acute disease throughout life.

These health and social disadvantages disappear only among the very old, as shown by lower death rates by sex for blacks in the over-85 group. One hypothesis suggests a "leveling effect," which reduces race differences in health and functional ability at the oldest ages (18). Mortality differences change in the same manner; beyond age 75, blacks have *higher* life expectancies than whites (19).[20] For heart disease mortality, this leveling effect occurs beyond age 85.

CEREBROVASCULAR DISEASE MORTALITY

Cerebrovascular disease (stroke) is a major cause of death for the very old. Although only 7 percent of deaths to persons aged 65 to 74 are due to strokes, this proportion reaches 14 percent for those over 85. **However, remarkably high rates of decrease in deaths from strokes among the elderly occurred during the 1970s, averaging 3 to 5 percent *per year.***

Key factors in reducing death rates from stroke are increased awareness, diagnosis, monitoring, and control of hypertension and levels of serum cholesterol. Recent reports from longitudinal studies suggest that improvements in diet, exercise, and other lifestyle habits also contribute to falling death rates from stroke (see ch. 4).

CANCER DISEASE MORTALITY

Cancers accounted for 19 percent of all deaths among the elderly in 1980.[21] Age-specific rates of this second leading cause of death among older persons (and among the general population) have increased in recent years, primarily due to a notable rise in the rates of lung cancer for older men and women of all races. In 1980 lung cancer among women aged 65 to 74 replaced breast cancer as the leading cause of female cancer mortality. Older black men have the highest rates of death from cancer among those over 85. In contrast, older black women have had lower or very similar mortality rates from all cancers when compared with older white women.

Recent studies of racial differences in the incidence of specific types of cancers among the elderly from 1973 to 1978 show a leveling effect between race, age, and incidence of most cancers among older men (16). No clear pattern of cancer incidence by race and age was discerned for women.

Although death *rates* from cancer increase by age within the older population, the increases are small when compared with those for deaths due to heart disease. **The likelihood of dying from cancer decreases with age; although 26 percent of all deaths among persons 65 to 74 in 1980 were due to cancer, this proportion sharply decreases—to just 10 percent—among those over 85.** Cancer is far more likely to be a killer of the young-old than the very old.

Future life span and prevalence of chronic diseases

Because the elderly are becoming an ever-larger proportion of the U.S. population, their physical and mental health status is an increasingly important concern. **Although recent decreases in death**

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[20] Caution is advisable in discussions of race differences in death rates among the elderly, especially the very old. Age-reported data for blacks are likely to be less accurate than for whites at the oldest ages, due in part to less accurate birth records for older blacks. Death rates for older blacks have been found to be understated. Thus, differences in data on elderly mortality rates by race are likely to be artificially greater than in reality (15).

[21] The proportion of deaths from cancer among persons over 65 is lower than for those 45 to 64. For the 45 to 64 age group, the proportion of deaths from heart disease is lower and the proportion of deaths from cancer is higher than for the elderly. Among persons 25 to 44, accidents are the major cause of death, followed by cancer and heart disease.

rates from heart disease and stroke among older Americans have ushered in a new period of increased old-age longevity, this quantitative increase has not been matched by qualitative improvements in the health status or functional abilities of the older population.

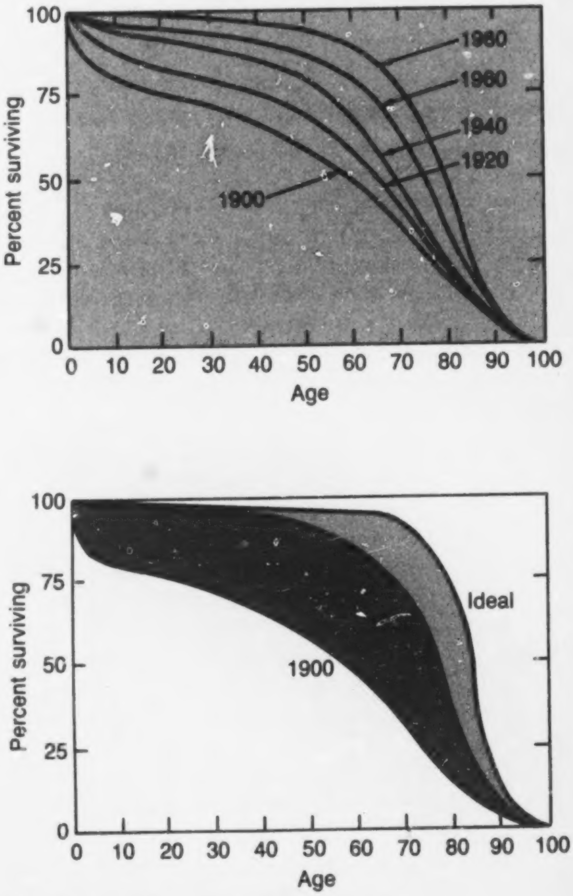
Chronological age continues to be directly associated with greater risk and incidence of most chronic diseases and functional impairments. Despite reductions in mortality rates from acute episodes of heart disease and stroke, the prevalence of chronic conditions associated with these and other diseases persists among the elderly. As populations age, they face an increasing prevalence of major mental diseases such as schizophrenia. affective disorders, brain syndromes associated with senile brain disease (e.g., Alzheimer disease) and arteriosclerosis, and epilepsy. This trend has been called the "rising pandemic of mental disorders and associated diseases" (11).

Pessimistic reviews of the prevalence of mental diseases in aging populations may be accurate in the short-term, but there is disagreement about their long-term persistence, their age of onset, new technologies that may alleviate or prevent them, and the consequences that can be expected at older ages in future decades (9).

There is general agreement that although notable life expectancy improvements should be achieved during the next two generations, there is an upper limit for human longevity (1,12), based on the belief that most types of human cells have an internally determined limit to the number of times they can reproduce (10). Some theorists accordingly suggest that mortality is not necessarily linked to disease and that future technologies to control or eliminate disease will *not* yield an ever-increasing or even a major increase in human life span.[22]

Other researchers estimate that the control or elimination of all major chronic diseases could produce a 20-year increase in life expectancy before biological limits on longevity take effect (10). As the "ideal curve" in figure 10 indicates, this scenario presents a maximum life expectancy at birth of no more than 86 years, because most of what has been called "premature death" from chronic diseases has already been eliminated. The large decreases between 1970 and 1979 in older age mortality are sometimes viewed as the beginning of the *final* "era" of improvement in life expectancy, whether at birth or at age 65.

Figure 10.—Past, Current, and Projected Ideal Survival Curves for the Population, United States, Selected Years, 1900-80



SOURCE: Adapted from Fries, 1980; and Strehler, 1975.

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[22] It is important to distinguish between the terms "life span" and "life expectancy," which are sometimes confused in discussions regarding longevity. *Life span* is best described as the biological upper age limit that any member of a species could possibly reach. Current estimates suggest a human life span of 110 to 115 years. As explained earlier in this chapter, *life expectancy* is a statistical measure of the expected average number of years to be lived for different subgroups of a population. For example, life expectancy at birth in 1983 was 74.7 years; for black males it was 65.2 years, while for white females it was 78.8 years. These two different constructs should not be used interchangeably.

Scenarios of the future also offer varying interpretations of the burden of chronic disease in the older population. One holds that although chronic disease incidence may increase, the average *age at onset* of these diseases and their disabling effects will increase faster than will life expectancy, producing a "compression of morbidity" in which the average period of chronic disease and disability in old age will be less than current levels. People would be ill or impaired for shorter periods of time before biological senescence led to death (7).

Another scenario projects longer average periods of disability and chronic illness in the future, based on the assumption that recent lifesaving and other health care technologies have had a greater impact on longevity than on the incidence of chronic disease. Increases in life expectancy would be accompanied by considerably longer periods of ill health and disability (9).

Still other models of aging find no clear evidence of an absolute limit on the longevity of human cells or on their ability to reproduce. Proponents of this view feel that all deaths are due either to accidents or disease, rather than to biological senescence (12). **Most reviews of available data indicate that recent advances in life expectancy at the oldest ages are due to technological advances in the diagnosis and treatment of chronic diseases and that the potential is high for further improvement in longevity from the control of chronic diseases.**

The experience of other countries with higher life expectancies, where the incidence and prevalence of the major killer diseases are notably different, is instructive. For example, Japan has a higher average life expectancy at birth than the United States (76.3 years as compared with 74.7), due in large part to much lower heart disease incidence and attendant mortality rates. But the major cause of death in Japan is stroke, which is ranked third in the United States. If Japan were to reduce its incidence of stroke to a level similar to that of the United States, additional years would be added to already high Japanese life expectancy. Similarly, if the United States could decrease its incidence of heart disease to Japanese levels, even greater increases in American life expectancy could be achieved.

If senescence rather than diseases were in fact a major killer, life expectancy at the *oldest* ages would *not* be showing such great improvement. Reductions in the *rate* of aging of cells, as demonstrated in nonhuman clinical and cellular studies, could possibly delay the age of onset of chronic disease as well as significantly increase life expectancy (21). **If future technologies reduce the rate of human cellular aging, then significant increases in human life expectancy *and* life span could occur with no corresponding increase in the period of morbidity among the elderly** (26).

Some researchers hold that we are on the threshold of major gains in human life expectancy because of prospects for identifying specific genes related to longevity[23] (30). New technologies may yield methods for improving the efficiency of the immune system. One method would control the problem of autoimmunity, in which the body's immune system attacks the "good" cells along with the "bad." Another approach contends that accumulated damage to DNA, the message center of the cell, results in decreased rates of DNA repair as humans age. New methods and technologies for improving the DNA repair rate for longer periods of time may, some researchers suggest, be a major step toward increased longevity. Another possible life span extension method is the nutritional restriction diet. Current studies on mice indicate that the rate of aging can be reduced and life span increased in mice that receive carefully restricted diets. The application of technologies such as antioxidant and membrane stabilization processes, altering neuroendocrine hormone balance by hypophysectomy (surgical alteration or removal of the pituitary gland), or drug therapy have also been hypothesized as life extension methods (3).

Some theorists suggest that combinations of two or more of these proposed technologies can yield 20- to 30-year increases in *life span* during the next generation. Recent work in these areas of life span extension and changes in rate of aging is provocative, but fails to answer questions about the application of *animal* study results to humans.

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[23] One example in humans is a part of the sixth chromosome that is considered the center of the immune system. It is known as the major histocompatibility complex and is being studied to understand its relationship to rates of cellular aging and immune functioning.

The long-term effects of applying such methods to humans remain unknown. Other questions concern the time period in which such applications or their effects, if any, could occur for human populations.

Recent data indicate that the age of onset and the prevalence of chronic conditions among the elderly have not changed in accord with recent increases in average life expectancy at age 65 (2,17). Because there is as yet no way to prevent (or effectively treat or cure) major chronic diseases such as osteoarthritis and Alzheimer disease, there is little reason to postulate declining incidence of these disabling conditions among elderly cohorts in the near future (see ch. 3). And as the older population ages in ensuing decades, the prevalence of these conditions could also rise.

Contrasting views hold that the data do not accurately account for today's healthier behaviors among portions of the younger population, as suggested by data on one subgroup of young persons that show lower blood pressure, serum cholesterol, and cigarette consumption levels than their parents' generation (4). Proponents of this belief argue that if healthy behaviors were encouraged among all age groups, healthier future cohorts of elderly persons would result (6).

Investigation of the implications of these behaviors for their possible long-term effects on health (e.g., heart conditions or osteoarthritis) and functional ability (e.g., Alzheimer disease) is in its infancy (see ch. 4). **But if projected gains in life span and/or average life expectancy were to be achieved within one generation, these dramatic changes would take place just as the baby boom cohort "comes of age" as the elderly boom of the 2010-25 period.** The implications of this possibility are profound in terms of both added productivity among the elderly and increased demands on societal resources.

Implications of chronic disease and disability

These emerging technological and demographic trends have important and varying implications for Federal policies related to the provision of health care, social services, long-term care, and income supports to the elderly. **The demand for these types of supports *and* the resources and capabilities that increased numbers of older persons contribute to society will depend on the nature of the population aging process and the period of morbidity that can be expected.** Additional impacts from these changes in technology and aging will involve the marital status, living arrangements, extended family size, work and retirement patterns, and other characteristics of future elderly populations characterized by higher life expectancies.

Given current indications, the following characteristics and consequences of an aging American population and anticipated technological change are likely to dominate Federal aging policy debates for the short-term future to the turn of the century:

- the growing prevalence in the older population of certain chronic physical and mental conditions, and functional impairments resulting from them, especially among the very old;
- in contrast to the predominance of the current acute-care medical model, a growing need to develop appropriate programs to care for persons with chronic conditions, including provisions for needed social as well as medical services;
- developing options and evaluating the relative costs, both public and private, for different modes of long-term care in different settings;
- questions regarding appropriate medications and evaluations of their positive or negative effects on older persons;
- the possible role of healthier behaviors in reducing the incidence or severity of chronic conditions and maximizing the quality and productivity as well as length of life at older ages;

- the role of informal v. formal social, health, and medical supports in responding to current and future long-term care needs of the elderly;
- the need for institutionalization in caring for those severely ill, highly dependent elderly and disabled persons who require the highest levels of 24-hour skilled nursing care;
- continuing pressure to contain the costs of medical, social, and long-term care services while maintaining their quality and accessibility for all persons;
- the increasing interest in and development of information technologies that can help the elderly in self-health care and maintenance of functional ability;
- the ability to respond to the preferences of most older people to live as independently as possible in comfortable, safe, convenient, and familiar residential settings for as long as possible;
- a growing range of housing options and technological choices that can respond to the desires and needs of older persons with various levels of functional impairments to carry on their daily activities; and
- the trends in labor force participation and functional status among the elderly and the potential for workplace technologies to either displace older workers or provide expanded opportunities for new or continued employment.

An important challenge in relation to these issues is the need to recognize the heterogeneity of the older population in terms of the attitudes, preferences, social characteristics, and health status of its members. It will also be important for Federal policy to carefully anticipate the growing numbers and proportions of older persons who will be most "at risk" of chronic disease and related disabilities. These "at risk" individuals will either require institutionalization or need some level of supportive health and social services in the community.

The following section focuses on the relevance of health, functional impairment, and the environment of the elderly to highlight the interdependent aspects of these characteristics and their impact on the lives of older Americans. The other chapters of this report present detailed information on these areas.

Severity of chronic conditions and patterns of institutionalization

In 1983 there were more than 1.3 million older Americans in nursing homes—5 percent of the over-65 population.[24] This is *twice* the proportion of elderly persons who lived in nursing homes in 1960. This increase is largely due to the aging of the older population itself and, in particular, to the prevalence of very old women who are widowed. These women are at high risk of institutionalization because they are most likely to live alone, to have no informal support network, and to be poor (i.e., eligible for Medicaid reimbursement for nursing home care; see chs. 7 and 9). If current age-specific trends persist, greater rates of institutionalization among the elderly can be expected as the population continues to age. At any one time, about 10 percent of the over-75 population are institutionalized. More than 1 in 5 (23 percent) of those over 85 are in institutions.

Recent projections, using revised 1977 baseline data, show an increase of 83 percent in the elderly nursing home population (to 2.2 million residents) by the year 2000. According to these projections, the very old will become an ever-growing portion of all older persons in nursing homes (see fig. 11). By 2020, when the young-old cohort of the elderly boom is 65 to 74, there could be 3 million elderly persons in nursing homes, more than one-half of whom would be over 85. **By 2040, as the elderly boom cohorts reach the very old ages, the numbers of nursing home residents could skyrocket to 5 million or more, three-fifths of whom would be the very old. Revised estimates that reflect the most recent aging trends would yield even higher numbers.**

The median *entry* age of nursing home residents has increased steadily since 1960 to the current age of 80. The median age of residents is 83. Although the young-old are largely able to avoid nursing homes, the growth of the old-old and their much higher risk of institutionalization will

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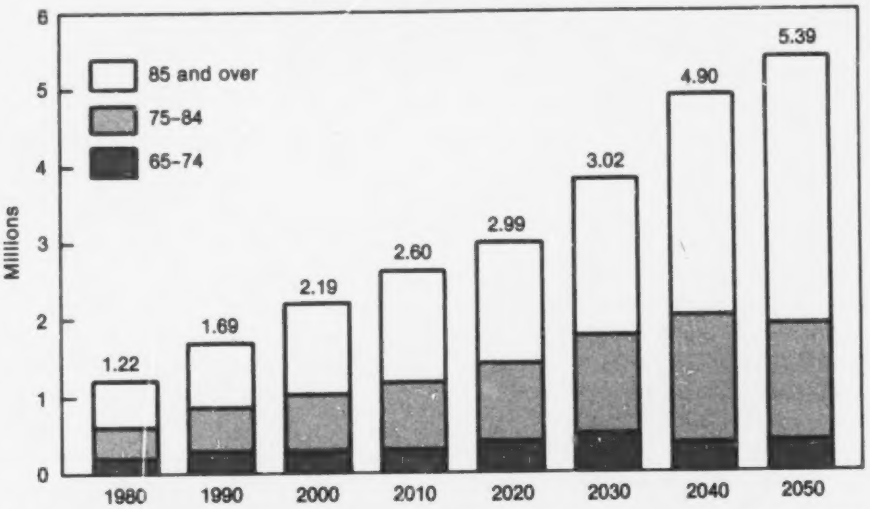
[24] Persons over 65 account for approximately 85 percent of all nursing home residents, a figure that has changed little during the last 25 years.

Figure 11.—Projections of the Nursing Home Population Aged 65 and Over, United States, 1980-2050



SOURCE: U.S. Senate, Special Committee on Aging, *Developments in Aging: 1983, Volume 1*, Washington, DC, Feb. 29, 1984. Based on most recent revised estimates of the 1977 population base, U.S. Bureau of the Census, Series P-25, No. 917-1977, estimated, and Series P-25, No. 922, October 1982. Middles Series Projections; and the National Nursing Home Survey (1977), National Center for Health Statistics.

be a major Federal concern in future years. **Unless the incidence of severe mental and physical disabilities related to increased prevalence of chronic diseases among the very old decreases, and assuming that the aging of the older population continues, a greater share of the total older population of the future can be expected to require either: 1) full-time skilled nursing care, primarily in institutions; or 2) increased custodial and other forms of long-term care in the community.** In fact, some estimates show that twice the number of persons now in nursing homes are in need of some type of long-term care in the community (2).

One consideration for Federal policy is the extent to which some proportion of this highly dependent population could be either equally or better cared for in a different residential setting. There is no consensus on the proportion of the institutionalized elderly who could be "released" from nursing homes. Estimates of those who could receive alternative forms of care or who are considered unnecessarily institutionalized range from none to more than 40 percent (29,32). The difficulties with such estimates lie in the different assumptions that are made regarding the institutional population's characteristics and the relationship of these characteristics to the types of care required. There is little evidence on which to base estimates of the numbers of current nursing home residents who could be cared for in other settings, in part because of a dearth of information on alternative settings and types of formal long-term care (see ch. 7).

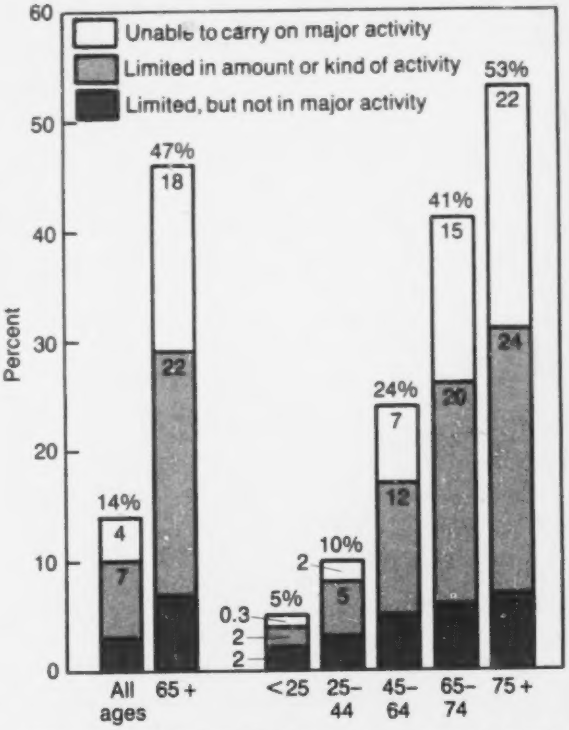
Nonetheless, three categories of characteristics are the strongest predictors of nursing home residency: 1) dependency in toileting and eating, 2) dependency in bathing and dressing, and 3) mental disorders (31). These highly interrelated predictors are particularly applicable for the very old and those who live alone. For example, the risk of mental confusion increases notably in the oldest ages and is sometimes the reason that individuals are unable to feed, bathe, or dress themselves. Estimates from national surveys and other sources indicate that, despite the primary diagnosis for admittance, about one-half of all elderly nursing home residents suffer some degree of mental confusion. Other data indicate that the degree of dependency among nursing home residents has increased, along with median age, since 1960.

Chronic conditions among the community-dwelling elderly

The community-dwelling elderly, who comprise 95 percent of older Americans, have a much lower prevalence of *severe* limitations and dependency than the institutionalized older population. In 1981 the most commonly reported chronic conditions for this great majority of the older population were arthritis (46 percent), hypertension (37 percent), hearing impairments (28 percent), and heart conditions (28 percent) (27). Although more than 85 percent of the noninstitutionalized elderly reported one or more chronic conditions in various surveys over the past 20 years, fewer than half of those who had such conditions reported any degree of activity limitation because of them (25). **Most older persons thus continue to be independent and active members of the community.**

Yet the extent of limitation among the elderly is notable when compared with other segments of the population, as shown in figure 12. Only 14 percent of the total noninstitutionalized population in 1981 reported some form of activity limitation (4 percent were limited in a major activity such as work). Among those 45 to 64, the total proportion whose activities were limited by chronic conditions was 24 percent. Both the prevalence and the severity of chronic conditions and their associated disabilities increase in old age. Fewer than one-third of those who are limited in the 45 to 64 age category are unable to carry on a *major* activity, but among those over 65, the proportion rises to almost two-fifths; among those over 75 the proportion exceeds two-fifths (see fig. 12). **Beyond age 85, some 60 percent of the community-dwelling elderly report activity limitation from a chronic condition and more than one-half of these persons are unable to carry on a major activity.**

Figure 12.—Limitation of Activity Due to Chronic Conditions, by Degree of Limitation and Selected Age Groups, 1981



SOURCE: U.S. Senate, Special Committee on Aging, *Developments in Aging: 1983*, based on National Center for Health Statistics, 1981 Health Interview Survey, unpublished.

Photo credit: Suzanne L. Murphy

The great majority of older Americans are active and contributing members in their community.

The severity of physical and mental limitations from chronic conditions is thus a critical problem—for the elderly in general and the *very old* in particular. The sharp increase in prevalence of dysfunctions among the very old is especially noticeable for **osteoarthritis, heart conditions, hearing and vision impairments, and urinary incontinence. Technological applications that can eliminate or mitigate the incidence of either**

the underlying chronic conditions or the limitations they present would yield major improvements in preserving the independence of older persons and their ability to function in the workplace, at home, and in the community.

Assistance for the functionally impaired who need help is provided by formal services, informal care from family and friends, or technologies in the home. Chapters 7 and 9 provide detailed reviews of these subjects, which are briefly discussed in the following section.

Socioeconomic characteristics and sources of assistance

Coinciding with the growth of the old-old and very old segments of the elderly population is the growth in numbers of older Americans who live alone. This trend is almost entirely attributable to the increase in the number of very old surviving women. In 1982 one-half of all older women were widowed, compared with only 12 percent of all older men. These proportions rise significantly among those over 75—to 69 percent for women and 22 percent for men (see ch. 9). Conversely, among all women over 75, only 22 percent were married and living with their spouse in 1982; for men, the corresponding figure was 70 percent.

A consequence of these differences is that women over 75 are far more likely to be living alone than men—45 percent of women as opposed to 19 percent of men. **These differences in marital status and living arrangements, coupled with older women's greater life expectancy, mean that very old women are far more likely to live alone and, therefore, are less likely to have informal assistance from a spouse or other person in the home.** By 1995 more than 55 percent of all elderly households are expected to consist of persons living alone or with nonrelatives; four-fifths of this population will be older women.

These trends indicate that the elderly are likely to require a greater variety of housing types and living environments than exist today. Higher proportions of single-person households, especially among the very old, are likely to increase the demand for congregate types of housing, residential-care complexes, and life-care communities. The functional status of the growing older population and their need for assistance will influence this demand for more supportive types of living arrangements. The ability of some elderly subgroups to pay for such environments and support services may be limited by low incomes. This is particularly relevant for the short-term future as increasing proportions of the elderly reach the oldest ages with little more than Social Security for their monthly incomes.

Older women are clearly at greatest risk of poverty. Low rates of labor force participation among women 45 to 64 in previous decades, compounded by low average income levels of those women who were in the labor force, indicate that greater numbers of old-old and very old women are likely to have incomes below the Federal poverty level for the next two decades. In 1982, 14.6 percent of all older persons were living below the poverty level. Twice as many older women who lived alone (28.7 percent) were in this category. Black women are especially vulnerable in this regard. Almost one-half of all black women over 72 had incomes below the poverty level, a rate *five times* that of their white male counterparts.[25] Almost 70 percent of black women who live alone have incomes below the poverty level (28). These differences are expected to persist for the remainder of this century.

Certain older Americans in fact face "quadruple jeopardy" in terms of higher risks of chronic disease, functional impairment, poverty, and living alone—those who are: 1) very old, 2) women, 3) widowed, and 4) black. Thus, the burdens of old age are far greater among the very old, especially among women and minorities. Although these elderly individuals are most likely to suffer impairments from chronic conditions, they are least likely to have informal supports or the resources to pay for formal care at home. And very old women who are widowed are a growing proportion of the older population. **If these trends continue, during the rest of this century a growing proportion of the older population in need of care is likely to rely on publicly subsidized sources of assistance, whether in long-term care institutions or in their own homes and the community.**

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[25] Older women in general have Social Security retirement incomes that are considerably lower than those of older men. Women's traditionally lower wages provide a much lower earnings base for calculation of Social Security retirement income benefits. Very old black persons, particularly women, are highly likely to receive only the minimum benefits.

The following chapters review the range of age-related issues that can be addressed by various types of technologies. Cost-effective technologies that improve the health and functional status of the elderly may help reduce the anticipated increases in per capita public and private health expenditures. Delaying the onset of major chronic diseases and improving their treatment or prevention will greatly enhance the functional independence of the elderly, making their lives more productive and meaningful. Technological adaptations of the living environment can assist older persons in adjusting to environmental demands, thereby promoting their independence and safety in the home and in the community. Longer years of life and new technologies for the workplace could provide opportunities for some older persons to fulfill their desires for a longer worklife or for second and third careers. Others may choose to expand their leisure and recreational activities in retirement.

In combination, these technological changes can enhance the well-being of older persons and maximize their ability to remain independent and active members of society. The U.S. Congress and Federal Government could directly and indirectly assist in this effort. The issues and options at the end of each ensuing chapter set forth some of the considerations for congressional review.

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Chapter 3

Selected Chronic Conditions, Technology, and Biomedical Research

Contents

Page
Introduction 61
Dementia: Social Problem, Medical Enigma, and Federal Burden 63
  Causes and Prevalence 63
  Effects on Patients and Their Families 64
  Clinical and Scientific Background 64
  Federal Roles Regarding Dementia 65
Urinary Incontinence 66
  Definition, Prevalence, and Causes of Incontinence 70
  Treatment 72
  The Cost of Incontinence 76
  Conclusion 77
Hearing Impairment in the Elderly 78
  Prevalence 78
  Types and Causes of Hearing Loss Among the Elderly 80
  Impacts of Hearing Impairment 82
  Treatment of Hearing Impairment 82
  The Service Delivery System 86
  Funding for Treatment of Hearing Impairments 87
  Federal Government Programs for the Hearing Impaired Elderly 88
Osteoarthritis 89
  Definitions and Prevalence 90
  What is Osteoarthritis 90
  Risk Factors 91
  Diagnosis 91
  Prevention of Disability and Treatment 92
  Quackery 94
  Social Factors 94
Osteoporosis 95
  Introduction 95
  Magnitude of the Clinical and Social Problem 95
  Biology and Physiology 96
  Diagnosis 97
  Treatment and Prevention 97
  Summary 100
Policy for Basic Biomedical Research 100
  Congressional Role in Supporting Research on Aging 101
  Reasons for Supporting Biomedical Research on Aging 103
  Resource Allocation: Who Decides What . . . 105
Conclusion 110
Congressional Issues and Options Regarding Basic Biomedical Research 110
Chapter 3 References 111

Tables

Table No. *Page*
5. Common Reversible Causes of Dementia . . 66
6. Types of Incontinence 71
7. Treatments for Urinary Incontinence 73
8. Causes of Conductive and Sensori-Neural Hearing Impairments 81
9. Treatments for Arthritis 92

Figures

Figure No. *Page*
13. Percent of Adults Aged 25 to 74 With Hearing Impairment, by Frequency of Tone in the United States, 1971-75 79
14. Physiology of the Human Ear 80
15. Diagram of Knee Joint 91
16. National Health R&D, 1972 and 1982, as Related to Total R&D Cost and Total Health Cost 102
17. National Support for Health R&D by Source, 1972-83 103

Chapter 3

Selected Chronic Conditions, Technology, and Biomedical Research

Introduction

Improved sanitation, health care, environmental protection, and greater affluence all contribute to extending the average length of human life. Technology is an essential element of each of the factors that improve health and extend life. Modern sanitation methods, for example, are based on scientific evidence of their potential effectiveness and the technological innovation that makes the transport and treatment of sewage affordable. New medical technologies that extend life include the use of drugs to successfully treat hypertension, thus reducing mortality from heart disease and stroke, and sophisticated devices, like computer-assisted X-ray machines, that permit more rapid and specific diagnosis.

The second half of the 20th century has seen a dramatic shift in the types of diseases afflicting people, especially in economically developed countries. The incidence of many infectious diseases has fallen sharply as sanitation has improved and vaccines have been developed; many of the remaining infectious diseases can be effectively treated with antibiotics. Death rates from diseases of the heart and blood vessels have also begun to change as a result of diet, personal habits, and improved health care. If trends continue, several predictions can be made:

- life expectancy will continue to rise,
- diseases whose incidence rises with age will become more common,
- environmental and dietary factors affecting health may become more important because individuals will live through longer periods of exposure and have longer to develop symptoms, and
- new and unexpected medical syndromes may appear.

Each of these factors may boost the number of people affected with chronic health conditions. Dementia, arthritis, deafness, poor vision, and other currently incurable ailments are likely to rise in importance as death rates from vascular disease decline and the prevalence of various cancers shifts (see app. A). There are four general strategies for dealing with chronic health conditions:

- treatment of acute episodes of illness arising from underlying chronic illness;
- long-term treatment or long-term care;
- prevention; or
- research to improve diagnosis, treatment, and prevention.

Policies regarding each of these interventions, except routine medical care, are discussed elsewhere in this assessment. Medical care for acute episodes of chronic illness and other aspects of hospital and ambulatory health care are discussed only briefly in this report because they are covered in both OTA reports on Medicare and in reports by other Federal agencies. Certain aspects of medical care, however, are covered in chapter 8.

Long-term care is discussed in chapter 7 and prevention in chapter 4. Questions regarding Federal policy on biomedical research on aging are addressed in the final section of this chapter.

An important result of the rise of chronic disease is the likely increase in prevalence of conditions that lack both cures and means of prevention and that become more common with age, such as osteoarthritis and Alzheimer disease. The shift from infectious to cardiovascular to other chronic conditions has followed a path of progressively greater clinical ignorance: those disorders that are now becoming more common are those about which we know the least. We know far more about the cause of tuberculosis than about the causes of Alzheimer disease. The most common causes of death and disability among Americans over 65 are reviewed in chapters 1, 2, 7, and in appendix A, which covers morbidity and mortality. The conditions selected for special review by OTA staff and the advisory panel for this assessment were chosen on the basis of several criteria:

- the condition is chronic and persistent;
- easily readable and current summaries of the state of science and medicine regarding the condition are not readily available;
- the elderly population is specifically affected due to severity or prevalence;
- technology is relevant to correction of or compensation for the condition;
- the condition contributes to the demand for long-term care, in line with the emphasis of the current assessment; or
- Congress has recently demonstrated a special interest in the condition.

The conditions identified by OTA staff and advisory panel members as most meriting discussion were dementia, urinary incontinence, hearing impairment, osteoporosis, and osteoarthritis. Visual impairments, diabetes mellitus, certain cancers, liver disease, and chronic lung disorders were also considered, but omitted due to limitations of space, which also dictated that the reviews be succinct and focused on policy.

Dementia was selected because Alzheimer disease and other dementing illnesses will soon become overwhelming health problems unless means for prevention or treatment are found. These diseases are severe, affect an important aspect of human function—mental ability—and are the most common determinants of need for long-term care. There are as yet no reliable or specific means of accurately diagnosing dementing disorders, although improvements have been rapid in recent years. Further, these disorders are probably not single entities, but combinations of related but biologically distinct diseases that have not yet been scientifically differentiated. The policy options relating to Alzheimer disease and dementia thus relate to long-term care for demented patients (see ch. 7) and to biomedical research. Although the ultimate solutions to dementing illness must come from research, they are not likely to be achieved in the short term, and the problem of caring for demented patients for the final few years of life cannot be avoided in the near future.

Urinary incontinence is a common problem. It is a symptom of many neurological, endocrine, vascular, and urological diseases that can now be treated with technologies ranging from absorbent pads to sophisticated mechanical devices. Because many of the relevant technologies are just coming to fruition, incontinence will be far more effectively treated in the future. Discussion of the problem of incontinence centers on the substantial delay in bringing technology to bear on the problem, and on possible drawbacks of present technologies. Improvements in this area could revolutionize nursing home care, and permit families to care for their incontinent dependents for longer periods before the patients become unmanageable. Even more important, great improvement can be made in individual patients' lives.

Hearing impairments affect 24 percent of those 65 to 74 and almost 40 percent of those over 75 in the United States. Many forms of hearing impairment can be improved by technological intervention—hearing aids and other devices. But the adaptation of appropriate technology to specific hearing defects of patients, especially elderly patients, has had only limited success. The potential for improvement of functional hearing impairments is substantial if patients can be convinced of the value of correction and if industry can adapt to better serving patients' needs. Technological innovation in this area promises to be rapid over the next decade. Federal policy issues include assurance of patient safety in public places (mandating alarms that can warn those with hearing impairments of danger), reimbursement policy for Medicare and Medicaid (which currently offer little support for those with hearing impairments), regulation of the hearing-devices industry, and sponsorship of training and research.

Osteoarthritis, which affects 16 million to 20 million older Americans, is the largest single cause of disability among the elderly. Technological issues related to osteoarthritis include a relative lack of basic scientific knowledge about the biology of cartilage, a need for preventive strategies, the potential for reducing pain and suffering for a large proportion of patients, and the enormous expense of current therapies, particularly joint replacement surgery. Like dementia, osteoarthritis is in need of discoveries that could lead to effective prevention and cure.

Osteoporosis is a disease process involving thinning of bones. Its most devastating consequences are fractures of the vertebrae and long bones, which are especially common in elderly women. Fractures of the hip often result in death. Current evidence suggests that osteoporotic fractures are amenable to prevention by such methods as increasing calcium intake or postmenopausal administration of estrogens, but the definitive preventive protocol has not been established because the various regimens used in routine practice have not yet been rigorously compared. Federal policy centers on the need for support of research to determine optimum prevention and treatment methods, basic biomedical research, and oversight of elevating the dietary standards for calcium (Recommended Dietary Allowances) to conform to the requirements of older women.

In conjunction with this assessment, longer separate reports, with additional scientific and technical background, are being issued by OTA on the impacts of neuroscience, technologies for managing urinary incontinence, and the management of hearing impairments.

This chapter summarizes OTA findings regarding each of the five selected chronic conditions, and discusses Federal policy with respect to biomedical research on aging.

Dementia: social problem, medical enigma, and Federal burden

Dementia is one of the most important disorders leading to chronic disability among older Americans. It affects fewer people than osteoarthritis, and is not a major *direct* cause of death like cancer or cardiovascular disease. In epidemiological studies, however, life expectancy *is* reduced by half among demented patients, making it the fourth or fifth highest cause of death among older people. Yet the effects of dementia are so devastating to the patient and his or her family, and its prevalence is increasing so rapidly, that one medical authority, Lewis Thomas, has called it the "disease of the century."

Causes and prevalence

Dementia is a serious social problem, a difficult medical enigma, and a major Federal expense. The loss of intellectual and other "higher" functions that is referred to as dementia can be caused by many different diseases and environmental insults.

The most common type of dementia is Alzheimer disease, which accounts for 50 to 75 percent of all cases. Up to 20 percent of patients with dementia have a disease that is treatable, and proper treatment can improve mental function in many cases.[1] Another 15 to 25 percent have dementia due to cardiovascular disease, stroke, or an accumulation of "mini-strokes." Another common cause is inappropriate drug treatment for other illnesses; many drugs used to treat cardiovascular diseases, psychiatric diseases, and insomnia lead to poor mental function. Mental function often improves when the offending medication is withdrawn, and failure to distinguish drug-induced dementia from true irreversible dementia can result in unnecessary mental confusion and inappropriate care. A substantial, but unquantified, number of older people suffer from transient confusion that spontaneously resolves or abates with medical treatment of another condition. Such acute confusional states pose a different set of medical problems than does chronic dementia; acute dementia is not explored further in this discussion. There are many causes of irreversible dementia, but the functioning of affected patients is generally similar regardless of cause; daily care techniques are thus also similar. Because stroke as a cause of dementia is, in general, treated as is stroke causing other symptoms, a scientific review of this type of dementia is not included here. In contrast, Alzheimer disease is the largest single cause of irreversible dementia, and little is known about its cause or means of prevention.

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[1] Common treatable causes of dementia include drugs, depression, and some cardiovascular and endocrine ailments.

Alzheimer disease, first described in 1906 by German physician Alois Alzheimer, leads to progressive loss of brain functions over a period of years. The cause is unknown and there is no effective standard medical treatment.

Alzheimer disease affects between 1.2 million and 4 million Americans; its true prevalence cannot be accurately determined because of variations in regional and historical methods of diagnosis of dementing illnesses. The term "Alzheimer disease," for example, was until recently restricted to those cases beginning before the arbitrary age of 65. Best estimates suggest that severe dementia affects approximately 2.5 percent of those over 65, and moderate and mild dementia probably afflicts another 2.5 to 10 percent. The disease becomes more common with age, affecting 20 to 30 percent of those over 80. More than half of all nursing home residents suffer from dementia.

Effects on patients and their families

The patient is usually aware of intellectual decline in the early stages of the illness. As the disease progresses, the patient loses touch with the outside world, first through loss of memory and intellectual functions, then through loss of personality and speech, and finally through loss of the ability to recognize even close relatives and spouses.

The effect of dementia on family and friends is devastating. Families care for the vast majority of patients with dementia. For the most part, only those in the final stages of severe dementia are placed in nursing homes or other institutions of long-term care. Families and friends are estimated to attend to 80 percent of the long-term care needs of patients in the United States (see chs. 7 and 9).

Beyond the financial and medical burdens imposed by those who develop this disease are the severe emotional strains faced by families and friends. The progressive intellectual deterioration of a close loved one is a tragic experience that can only be fully understood by those who have gone through the process; it has been described by one family member as a "funeral that lasts for years." The arduous task of caring for patients with dementia is tellingly described in a book called *The 36-Hour Day*.

Clinical and scientific background

The clinical changes of Alzheimer disease are associated with physical and biochemical changes in the brain. Accumulations of abnormal proteins and other material are found in "plaques" in the cerebral cortex of the brain, as are accumulations of abnormal fiber-like proteins within nerve cells. Specific populations of nerve cells in the nucleus basalis of Meynert, near the base of the brain, die for unknown reasons. The death of these cells is postulated to be related to the clinical symptoms.

Patients die *with* this disease, not *of* it. Patients with dementia have only half the usual life expectancy for a given age; not because it kills in and of itself, but because patients become susceptible to other diseases as a consequence of being unable to take care of themselves and because of immobility caused by the end stages of the disease. At present, its cause *is* unknown, and there are no means of prevention. The absence of effective medical intervention has diminished the incentives to physicians to provide accurate and well-documented diagnosis; if the cause of illness does not affect treatment choices, there is less reason to identify it. Greater awareness of the fact that up to 20 percent of dementia is treatable could improve physician attention to accurate diagnosis of dementia. Growing public awareness of Alzheimer disease has drawn medical attention to the disorder, yet one of the most important reasons for accurate diagnosis is often overlooked—families of patients know that something is wrong, but do not know what. The specific diagnosis of organic brain disease is unwelcome, but may reduce the anxiety and guilt felt by patients' families by identifying the problem as an organic brain disease rather than a problem of family or interpersonal dynamics.

The widespread belief in dementia as a normal concomitant of aging has historically served to lessen physician interest in the disease. The problem of diagnosis has been further hampered by physicians who inaccurately ascribed dementia to atherosclerosis or other cardiovascular dysfunction. Diagnostic methods are now changing rapidly, and heightened awareness has led to a dramatic increase in specific diagnosis by physicians. Nevertheless, there is great uncertainty about the real prevalence of Alzheimer disease.

Although there is a genetic form of the disease, which runs in families (much like such genetic diseases as Huntington disease), it is not yet certain how many cases of Alzheimer disease are of the familial type; estimates of the number of patients who have a genetic form vary from fewer than 10 percent to more than 60 percent. Determining the genetic basis of Alzheimer disease is an important objective for research, especially if a marker for the disorder could be found to aid in diagnosis in affected families. Various causes of the disease have been postulated, including unusual infectious agents ("slow viruses"), aluminum toxicity, reaction of the body against itself (autoimmune disorder), and various biochemical abnormalities. Many research leads are promising, but none are yet conclusive.

Federal roles regarding dementia

The basis of Federal concern about Alzheimer disease is not only in its prevention and treatment, but in payment for the care of patients. Because dementing illnesses account for admission of most nursing home residents, they are a major aspect of long-term care and institutionalization (see ch. 7). The Health Care Financing Administration has estimated that the Federal Government spends over $6 billion annually in nursing home costs alone for those affected with Alzheimer disease (approximately 30 percent of the total Federal outlay—1982 data). An additional $2 billion to $4 billion in Federal funds are spent each year on acute hospital, home, and rehabilitative care for these patients.

Federal concern about Alzheimer disease is intensifying as its prevalence increases with the rapid growth of the oldest segments of the American population. The magnitude of health care costs, especially for long-term care, has focused new attention on the scientific and medical need to study this disease.

Concern among physicians, researchers, and other health care professionals has led to rapid advances in the study of Alzheimer disease in the last decade. A significant factor has been the creation of the National Institute on Aging (NIA), which has made a major commitment to the study of dementia. In 1984, for example, NIA earmarked $3.5 million to establish up to five "centers of excellence" for the study of Alzheimer disease in response to congressional appropriations. The National Institute of Neurological and Communicative Diseases and Stroke (NINCDS) and the National Institute of Mental Health (NIMH) have also increased research on dementia. Total Federal research funds on Alzheimer disease for 1984 are estimated at $36.4 million to $37.8 million, up from $3.8 million in 1976. Recent discoveries of specific nerve-cell loss, of the nature of the anatomic abnormalities, possible infectious agents, and of biochemical changes have all emerged from federally funded research during the last decade.

Recent findings in neuroscience have led to experimental drug therapies directed at particular chemical nerve-cell connections in the brain. There has been preliminary success with drugs that allow the neurotransmitter acetylcholine to work longer at its anatomic site. The neuropeptide vasopressin has been shown to improve memory slightly in some patients with Alzheimer disease. The drug naloxone, which is used to treat some forms of acute opiate overdose, has also been reported effective in one small study, but following studies have not shown a significant effect. Tests have begun on drugs that might increase the efficiency of releasing acetylcholine into its active site by altering calcium metabolism and other biochemical pathways. Federal policy regarding support of randomized clinical trials of various therapies will affect the pace at which effective drug treatments are identified and accepted by the medical community. Preliminary findings offer hope for at least a partially effective symptomatic treatment. Solving the problem of dementia may well depend on developing effective means of prevention, which will, in turn, depend on understanding its cause and the mechanisms of its progression.

There is also a role for the Government in *protecting* those who have Alzheimer disease. For example, who is to decide when it is proper to conduct research on a demented patient? The patient is by definition not able to give informed consent, which requires understanding of the purpose and process of experimentation. Obtaining informed consent can be a barrier to scientific investigation of just those treatments that are so needed. The dual role of the Federal Government in both preserving civil rights and supporting most biomedical research suggests that informed consent for Alzheimer disease research may be an emerging Federal issue.

Treatment and prevention of this dread disease can only come from investment in neuroscience research (see table 5). The United States has a social, financial, and medical stake in the solution of this major health problem. The Federal Government already sponsors research, pays for acute care and diagnosis through Medicare, and is responsible for long-term care through Medicaid. Cost savings in health care for the rising population of demented patients depend on finding new, effective, and inexpensive treatments for dementia and determining methods of prevention for Alzheimer disease and other dementing illnesses.

Table 5.—Common Reversible Causes of Dementia

Drugs:
- Sleeping pills and sedatives
- Other psychopharmaceuticals
- Anti-Parkinson's drugs
- Other neurological drugs
- Anti-hypertensive drugs
- Other cardiovascular drugs
- Opiate analgesics
- Many others

Depression and psychosis

Infections:
- Colds
- Flu
- Lung (pneumonia)
- Brain
- Brain membranes
- Blood
- Kidney
- Digestive tract
- Many others

Stroke *(often at least partially reversible):*
- Blood clots in or around the brain
- Occlusion of blood vessels feeding the brain

Heart failure

Disorders of endocrine function:
- Thyroid hormone
- Parathyroid hormone
- Hormones and substances affecting blood volume control
- Stress-related hormones
- Others

Nutritional disorders:
- Vitamin B_{12} deficiency
- Folate deficiency
- Protein deficiency

Anemia

Metabolic and electrolytic imbalances:
- Calcium
- Sodium
- Potassium
- Others

Trauma:
- Head injury
- Shock

Toxicity:
- Occupational exposure
- Environmental exposure (lead, carbon monoxide)
- Household exposure (pesticides)

SOURCE: Office of Technology Assessment.

Urinary incontinence

Urinary incontinence is detrimental to the physical health, psychological well-being, and social functioning of those afflicted. This condition disrupts the lives of 5 million to 10 million Americans, their families, friends, and caregivers and is most common among those over age 65. Incon-

OTA Fact Sheet on Alzheimer Disease

How big is the problem?

- Alzheimer disease affects 5 to 15 percent of those over 65 (1.2 million to 4 million Americans).
- Alzheimer disease is more common with advancing age, affecting more than 20 percent of those over age 80.
- Alzheimer disease imposes severe financial, medical, and emotional stresses on families:
  - —A full diagnostic evaluation costs $300 to $2,000.
  - —Families bear fractions of diagnostic and therapeutic costs, and almost half of the overall cost of long-term care directly out-of-pocket.
  - —Families suffer loss of a productive member, often leading to sudden and substantial reduction in income.
- Alzheimer disease accounts for an estimated 30 to 50 percent of those in nursing homes.
- Alzheimer disease is the most frequent cause of institutionalization for long-term care.
- Federal funds for long-term care in 1980 were $12 billion ($10.4 billion from Medicaid, $0.4 billion from Medicare, and $1.1 billion from the Veterans Administration). These costs, under present arrangements, will escalate to $24 billion by 1985, and $43 billion by 1990. Alzheimer disease accounts for 30 to 50 percent of this spending.
- Alzheimer disease accounts for an estimated 50 to 75 percent of dementia ("senility"). The remaining fraction is due to cardiovascular disorders, stroke-related diseases, and more than a dozen treatable causes of dementia.
- Alzheimer disease is often misdiagnosed; 8 to 23 percent of those said to have this disease may actually have depression or other treatable disorders.
- Chances are better than 50 percent that one of one's grandparents would develop the disease if all lived past age 65.

What is it?

Alzheimer disease is an organic brain disease named after the German physician, Alois Alzheimer, who first described it in 1906. Alzheimer disease causes progressive loss of mental functions over a period of years. Its clinical progression is usually divided into three stages:

1. Mild cognitive deterioration is quite difficult to distinguish from normal function, and is usually first detected by loss of memory for recent events. Difficulties in speech and word-finding; loss of the ability to "think through" complex actions or interpret complex stimuli soon follow. The first signs noted can, however, vary greatly among patients.
2. This is followed by worsening cognitive deterioration and personality changes, often including irritability, and severe disorientation as to time and place. The patient's speech often remains fluent and grammatical, but the content of what is said is often inappropriate or disconnected from reality.
3. Finally, the patient shows complete loss of intellectual abilities, leading to a state of vegetation. This includes the inability to speak or recognize even close relatives, and complete loss of "world knowledge."

It is highly probable that what is now called "Alzheimer disease" or "senile dementia of the Alzheimer type" is a *group* of several distinct diseases, with different causes and mechanisms. There is tremendous variation in the duration of the illness and its rate of progression. Younger patients tend to have more severe cases which progress more rapidly. Alzheimer disease can last from a few years to a few decades.

How is the diagnosis made?

The diagnosis of Alzheimer disease can now be made only by excluding other causes of dementia. Diagnosis is certain only when made at autopsy, by finding a profusion of the three pathologic indicators of Alzheimer disease:

- "Senile" or Alzheimer plaques (neuritic plaques)—accumulations of proteins and cellular debris also found in other diseases, but not in such numbers or in the variety of anatomic locations as in Alzheimer disease.
- Neurofibrillary tangles—accumulations of fiber-like proteins inside of cells, also found in several other disease states, but with a different distribution and in lesser numbers.
- Granulovacuolar bodies—enclosed bundles (vacuoles) of material of uncertain origin found inside cells. They are restricted to specific regions of the brain, and are rare in other diseases.

None of the pathologic changes is unique to Alzheimer disease. The pathologic diagnosis is based on seeing a large number of the plaques, tangles, and granulovacuolar bodies in places not usually associated with other diseases. There are, however, certain groups of nerve cells in specific anatomic locations that appear to be lost in Alzheimer disease much more than in other disorders. Correlation with clinical symptoms is essential to definitive diagnosis.

What are other important points?

- It is not clear whether Alzheimer disease is a consequence of aging or a specific disease which affects only a susceptible population. Present medical belief favors the latter hypothesis; historically, the relative dominance of these beliefs has alternated.
- All statistics on incidence and prevalence are highly uncertain because:
  —Alzheimer disease patients die *with* the disease, not *of* it. This leads to underreporting on death certificates.
  —Patterns of diagnosis of psychiatric and neurological diseases have changed drastically in the last decade. "Alzheimer disease" used to refer only to those patients affected before the arbitrary age of 65.
  —Alzheimer disease patients often are not referred to a neurologist or psychiatrist for specific diagnosis. Terms such as "senility," "cerebral arteriosclerosis," "organic brain syndrome," "chronic brain syndrome," and "dementia" often serve as substitutes for an accurate and specific diagnosis. Nonspecific and uncertain diagnosis make data on dementia unreliable, especially when not gathered by neurology or psychiatry departments.
  —There is no fully effective treatment at present, although several new drug therapies are promising.
  —There is no specific "marker" for the disease. Thus the diagnosis is made by excluding other causes of poor mental function. This leads to diagnostic error. There is a need for accurate and cost-effective diagnosis.
  —The disease starts as the patient's and ends as the family's: the patient's medical problem soon becomes a financial and emotional drain on the family. Many of the most distressing effects of the disease are borne by friends and relatives, not by the patient.
  —Self-help groups, such as the Alzheimer Disease and Related Disorders Association, are trying to aid in family support and as information clearinghouses.
- There are no effective means of prevention.
- Because the ability of the patient to decide for himself or herself is often questionable, the procedure for obtaining informed consent may be unclear, leading to legal and ethical problems in research and treatment.
- Families are often prudent in seeking transfer of power of attorney well in advance of the time when medical and financial decisions must be made on behalf of the patient.

What are some possible causes?

- Loss of nerve cells in specific areas of the brain (nucleus basalis of Meynert, hippocampus, locus ceruleus) may be one cause, analogous to Parkinson's disease. The reason for the loss is unknown.
- Genetic factors may account for 10 to 60 percent of cases. The wide range in estimates is due to scientific uncertainty. There is definitely at least one genetic form, in which an affected person's sons or daughters are each at 50 percent risk, but the prevalence of the genetic form is controversial.
- An atypical infectious agent ("slow virus"), analogous to that which causes some other dementing diseases, has been suggested. The other diseases are caused by unusual infectious agents that remain dormant for years, and then cause unremitting neurological illnesses which terminate in death after a clinical course of one to a few years. Alzheimer disease is similar to these other diseases in several respects, but there is only circumstantial evidence of causal similarity at present.
- Condensation of fibrillar proteins in neurons, of unknown cause, may lead to interference with normal nerve-cell function, eventually resulting in cell death.
- Aluminum and silicon are found in high concentrations in the plaques of those affected with Alzheimer disease. One hypothesis is that cell death is due to some variety of "aluminum poisoning." There is no agreement on whether the aluminum accumulation is a cause or an *effect* of cell death and biochemical changes in Alzheimer plaques.
- It has also been suggested that Alzheimer disease may be an immune disorder, caused by the immune system reacting against the brain, leading to cell death. This would be analogous

to other diseases such as systemic lupus erythematosus or myasthenia gravis.

- A biochemical aberration of calcium metabolism may lead to insufficient release of neurotransmitter.
- There may be a disorder of glycolytic biochemical pathways (pyruvate dehydrogenase) leading to decreased calcium influx into the cell and insufficient release of neurotransmitter.
- Disorders of neurotransmitters other than acetylcholine may be involved as well. Those suggested include:
  —somatostatin,
  —norepinephrine (from the locus ceruleus),
  —vasopressin, and
  —endogenous opioid peptides. This last is supported by clinical reports of improvement by treatment with naloxone, a chemical blocker of opiate receptors.

What potential therapies are under investigation?

- Infuse drugs that simulate the actions of acetylcholine directly into the fluid surrounding the brain. Four patients, in a recent trial, received such drugs from a pump implanted in the patient's body and families reported improvement or stabilization of symptoms.
- Stimulate acetylcholine *synthesis* (lecithin, choline)—not very successful to date.
- Administer piracetam, a drug which improves some aspects of mental function, alone or in combination with other drugs.
- Use drugs that mimic the effect of acetylcholine, either alone or in combination.
- Stimulate acetylcholine *release* with 4-aminopyridine and related agents.
- Increase the *duration of action* of acetylcholine by inhibiting breakdown by anticholinesterase drug therapy. The best example is physostigmine.
- Chelate aluminum to prevent toxicity with fluoride, tetracycline, or deferoxamine.
- Use naloxone to block opiate receptors.
- Use vasopressin to improve memory.
- Breathe hyperbaric oxygen (not very successful).
- Use ergoloid mesylates (Hydergine—only marginally effective, used widely in Europe).

Of these treatments, those affecting acetylcholine have shown moderate, but inconsistent improvement. Ergoloid mesylates administration has been shown to have an effect in numerous trials, but the effect is so minor that it may not be clinically relevant.

What are some potential developments in the long run?

- Research may yield a specific diagnostic test for Alzheimer disease. Such a test could develop from biochemical tests on tissue from brain biopsies, chemical metabolites in cerebrospinal fluid, or monoclonal antibodies to proteins that are possibly specific to Alzheimer disease.
- Use of nerve-cell implants (so-called brain-cell transplants) is promising, but many technical obstacles remain. The treatment has worked in animals with a disease resembling Parkinson's disease, and human grafts have grown successfully in experiments conducted in Scandinavia. The human experiments have not yet been clinically useful, and many problems regarding what tissue to use as a source of implantable nerve cells must be solved. Successful implant therapy for Alzheimer disease also awaits knowledge of the nerve cells that need to be replaced.
- Understanding of the biochemical and neurotransmitter defects may allow specifically targeted therapy, based on the physiology of the affected parts of the brain. One promising avenue to learning about this is through development of animal models based on finding chemicals that specifically destroy certain parts of the brain or particular types of nerve cells.
- Understanding a cause or causes (whether viruses, other infectious agents, or environmental toxins) may permit effective prevention.
- Identification of genetic markers, analogous to those known for sickle cell disease or Huntington disease, would prove useful for investigating the putative molecular defect, as well as helping in diagnosis of members of affected families for family and personal planning.
- Genetic treatments may be possible, based on studying human genes in other species (e.g., hamsters or mice), and identification and specific study of those genes, if any, that predispose to dementia. It may also be possible to deliberately engineer nerve cells with needed characteristics to replace or supplement cells that have died.

tinence also constitutes a costly health problem: the U.S. Surgeon General estimates that $8 billion is spent on incontinence in this country each year (37). Because it is often difficult for affected individuals and their families to cope with the condition at home, incontinence may play a pivotal role in the decision to enter a long-term care facility.

Despite the availability of many effective forms of treatment, incontinent persons are rarely evaluated thoroughly enough to determine the precise causes of the condition and are therefore not treated optimally. Some estimate that up to one-third of incontinent patients could be completely cured (38,73). Several factors contribute to the deficiency in care of incontinent persons in this country, including: 1) lack of knowledge about the specific diagnosis and optimal treatments for different types of urinary incontinence; 2) reluctance of affected individuals to seek medical help because of embarrassment, social stigma, and the misconception that it cannot be treated (largely because of lack of awareness of available treatments); and 3) scant, inconsistent Federal and State reimbursement policies for urinary incontinence treatment and products, especially for the noninstitutionalized.

This section briefly explores these barriers to adequate medical care for incontinent persons, looks at the technologies available for treatment, and proposes some ways in which the government might act to reduce the magnitude of the medical, social, and economic impact of urinary incontinence in this country.

Definition, prevalence, and causes of incontinence

Urinary incontinence is defined as an involuntary loss of urine sufficient in quantity and frequency to be a social or health problem. The severity ranges from occasional dribbling to total loss of control over excretion of both urine and stool (fecal incontinence is much less common and is not discussed in detail here). Between 10 and 20 percent (2 million to 4 million)[2] of community-dwelling elderly have some degree of incontinence. The prevalence increases to between 40 and 50 percent of those elderly in nursing homes (600,000 to 700,000). In comparison, between 1 and 5 percent of those under age 65 (2 million to 10 million) have a persistent problem with incontinence.

Data subdivided by severity for community-dwelling elderly persons are scarce but British studies suggest that 5 percent are severely affected (one or more episodes daily) and 9 percent are less severely affected (68). More than two-thirds of affected individuals (or over one-third of the total patient population) in nursing homes have more than one episode a day (59). Although incontinence of both urine and stool is relatively uncommon in community-dwelling persons, close to 50 percent of those in nursing homes who are incontinent of urine also have episodes of fecal incontinence (46,59). Most patients with both kinds of incontinence also have severe impairments of mental and/or physical functioning.

Disorders of the lower genitourinary tract, disorders of innervation and neurological control over genitourinary function, lack of mental awareness of the need to void, and limitations in mobility or environmental factors (e.g., restraints or drugs) can all contribute to the development and persistence of incontinence. The many types of urinary incontinence can be divided into two general categories, acute and persistent (see table 6), for which the causes and the clinical approaches are distinct.

Acute incontinence refers to the sudden onset of episodes of involuntary urine loss that are usually associated with an acute illness, or environmental factors that impair the mental or physical ability to reach a toilet or toilet substitute. Especially common in hospitalized elderly, acute incontinence can be precipitated by impairment of mobility (as with hip fracture) or some type of bed restraints; such patients may recognize the need to void but may not be able to obtain timely help in getting to the toilet. Other causes of acute incontinence include: acute urinary tract infections with bladder inflammation; metabolic dis-

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[2] Accurate, consistent prevalence data for urinary incontinence are scarce, especially for community-dwelling persons, because of underreporting due to social stigma, reluctance to seek medical help, and lack of diagnosis. The figures given here are therefore rough and probably underestimates.

Table 6.—Types of Incontinence

Definition	Causes	Population(s) affected
Acute: Incontinence of sudden onset associated with an acute illness (and/or other factors) that subsides once the acute condition has been resolved or other factors have been removed.	Acute illnesses associated with one or more of the following: (a) immobility and/or environmental factors that diminish the ability to get to and use a toilet, (b) impaired mental function that diminishes toileting ability, (c) fecal impaction. Acute urinary tract infections. Drugs: (a) those that increase urine flow (e.g., diuretics), (b) those that inhibit bladder contractions and cause urinary retention and overflow (e.g., anticholinergics), (c) those that decrease mental awareness (e.g., sedatives, hypnotics). Metabolic—increased urine flow (polyuria) associated with poorly controlled diabetes.	Elderly, usually in acute hospitals.
Established:[a] *Stress:* Leakage of small amounts of urine with increases of intra-abdominal pressure (e.g., coughing, sneezing, laughing, exercise).	Weakened supporting tissue surrounding bladder outlet and urethra associated with: (a) lack of estrogen in postmenopausal women, (b) previous vaginal deliveries, (c) previous pelvic surgery (e.g., hysterectomy).	Women, especially those over age 40.
Urge: Leakage of urine caused by inability to delay voiding long enough to reach the toilet after urge to void is felt.	Neurological disease such as stroke, dementia, Parkinsonism, muliple sclerosis, spinal cord diseases. Genitourinary disorders such as unstable bladder ("detrusor instability"), bladder stones, diverticuli of urethra and bladder, atophic urethritis, vaginitis (females), chronic cystitis, mild outflow obstruction (usually males).	Men and women of any age; most common in the elderly.
Overflow: Leakage of small amounts of urine associated with obstruction to urine flow.	Hypotonic or acontractile bladder associated diabetic neuropathy, spinal cord injury, or drugs such as anticholinergics (which inhibit bladder contractions), smooth muscle relaxants, narcotics, and alcohol. Anatomic obstruction associated with prostatic enlargement or urethral stricture.	Older men with prostatic enlargement. Diabetes.
Functional: Inability or unwillingness to reach a toilet in time.	Impaired mobility. Impaired mental function. Inaccessible toilets (or caregivers). Psychological disorders such as depression, psychosis, anger or hostility.	Elderly in acute hospitals and nursing homes and those with acute or severe psychiatric illness.

[a] Incontinence is persistent and unrelated to an acute illness.

SOURCE: J. Ouslander, R. Kane, S. Vollmer, and M. Meneras, "Medical Devices for Urinary Incontinence: A Case Study," prepared for the Office of Technology Assessment, contract No. 333-6550, December 1983.

orders that increase urine flow, such as diabetes; fecal impaction that may mechanically obstruct normal bladder emptying or cause reflexive involuntary bladder contraction; and a variety of drugs. Drugs that can induce urinary incontinence include: diuretics that increase urine flow; sedative, hypnotic, and antipsychotic drugs that may diminish mental awareness of the need to void; and drugs that influence lower urinary tract functioning, such as anticholinergic drugs (that inhibit the bladder from contracting) and certain antihypertensive drugs (that decrease resistance in the bladder outlet) (36,64).

Persistent or established incontinence (i.e., repeated episodes not associated with an acute condition) can be divided into four types:

1. *Stress incontinence* usually occurs in women, especially those whose musculature has been weakened by multiple vaginal deliveries or

pelvic surgery. It involves the leakage of small amounts of urine with increased abdominal pressure such as that associated with exercise, straining, coughing, laughing, or sneezing.

2. *Urge incontinence* involves leakage of varying amounts of urine because of inability to delay voiding before reaching a toilet. It can be, but is not always, caused by a variety of genitourinary and neurological disorders such as involuntary bladder contractions, or local irritation of the bladder or the urethra.
3. *Overflow incontinence* involves leakage of small amounts of urine and is caused by anatomic obstruction to bladder emptying (as by an enlarged prostate in men) and/or impaired ability of the bladder to contract (as with diabetes, spinal-cord injuries, and certain drugs).
4. *Functional incontinence* occurs in those individuals who have chronic impairments of either mobility or mental function, are unable to use a toilet independently, or are unable to maintain continence because of psychological disturbances. This type of incontinence may also be induced by iatrogenic factors such as medication or environmental barriers (e.g., restraints).

Treatment

Determining the appropriate treatment for an individual with urinary incontinence requires a thorough evaluation of all relevant factors—genitourinary, neurological, psychological, and environmental—that could be causing or contributing to the condition. Unfortunately, health professionals commonly do not recognize incontinence, especially among community-dwelling older persons, or fail to note it as a problem and therefore do not pursue an evaluation (59). The problem is compounded by the reluctance of many afflicted individuals who are too embarrassed to seek medical help or believe that nothing can be done about it.

Fewer than 5 percent of incontinent patients in a nursing home setting are estimated to have had any specific evaluation of their incontinence (59). Many could benefit from such an evaluation because it could lead to a cure or to treatment that significantly ameliorates their incontinence. Some experts estimate that one-third of incontinent patients can be completely cured and most others could be kept comfortable and dry with appropriate management technologies (38,73). Unfortunately, there have been very few studies on the relative efficacy of various treatments for different types of incontinence. Only a handful deal specifically with the elderly and most report on fewer than 10 patients (72).

When treated inadequately or inappropriately, incontinence can lead to skin breakdown and recurrent urinary infections. In addition, inadequate treatment can exacerbate the incontinence and thus increase the psychosocial impact, leading to further loss of self-esteem and withdrawal from social activities that may exacerbate isolation and depression. Studies in Great Britain indicate that incontinent individuals often are reluctant to utilize services available to them such as incontinence nurses, incontinence clinics, and laundry services (e.g., 67,68,74,75).

Many technologies are specific to a particular type or types of incontinence and attempt to cure the problem (e.g., artificial sphincters, electric stimulators, drugs, training procedures, and surgery). Diagnostic evaluation is thus critical to the appropriate use of these treatments. Other treatment technologies are nonspecific and palliative rather than curative (bed pads, undergarments and, in some situations, catheters). In general, these technologies should be used as a last resort after diagnostic evaluation has excluded treatable conditions.

The various types of technologies for the treatment of urinary incontinence, along with their mechanisms of function and appropriate uses, are described in table 7. In order to discuss their advantages and disadvantages, these technologies are divided into four categories in the discussion that follows: devices, surgery, drug treatment, and training procedures. Again, little is known about the relative efficacy and long-term cost effectiveness of the various treatments for urinary incontinence.

Table 7.—Treatments for Urinary Incontinence

Examples	Mechanism	Uses
Devices:		
To collect urine before leakage occurs:		
Catheters	A flexible tube is placed directly in the bladder and drains urine into a collecting bag. Can be used continually or intermittently.	Inability to empty bladder (urinary retention) that cannot be corrected by surgical or drug treatment. (This may or may not be associated with overflow incontinence.) Incontinence associated with healing skin lesions.
To collect urine after leakage occurs:		
NASA (female) Condom catheters (male)	Outflow is trapped and drained into a collecting bag.	Any type of incontinence.
Bedpads	Pad protects individual and mattress from contract with urine. These pads are disposable or reusable.	Any type of incontinence especially, useful as adjunctive therapy with other treatments.
Prevent or delay urine outflow:		
Artificial sphincters	Inflatable cuff is surgically implanted around urethra and inflated to prevent urine outflow.	Incontinence associated with sphincter weakness (usually stress incontinence or postprostatectomy)
Inflatable cuff		
Silicone-Gel prosthesis	Silicone-gel is inserted to replace existing urethra.	
Periurethral Teflon	Teflon paste is injected into tissues surrounding urethra.	
Electrical stimulators	Device inserted into vagina; produces electric impulses that (a) cause contraction of pelvic floor musculature (b) inhibit bladder contractions.	Incontinence associated with pelvic floor muscle weakness or bladder instability.
External clamp (male)	Penis is clamped to prevent urine flow.	All types of male incontinence.
Pessary (female)	Device is inserted into vagina, supporting tissues below bladder and around urethra.	Female incontinence associated with prolapsed pelvic structures (usually stress incontinence).
Other treatments:		
Surgical procedures:		
Bladder-neck suspension	Urethra and bladder neck are restored to a more normal intra-abdominal position.	Female stress incontinence.
Prostatectomy (transurethral resection and suprepubic)	All obstructing portion of prostate is removed.	Male overflow incontinence associated with anatomic obstruction.
Therapeutic bladder-neck transection	Bladder neck is surgically incised.	Urge incontinence associated with bladder instability.
Selective bladder denervation (cystolysis)	Nerves to upper bladder are cut so that there is no muscle control of bladder dome, but sphincter mechanism is intact.	Urge incontinence associated with bladder instability.
Therapeutic bladder distension	Bladder is distended under anesthesia for at least two hours to a pressure close to systolic blood pressure.	Urge incontinence.
Correction of other genitourinary pathology (e.g., bladder tumor or stone).	Removal of irritative or obstructive factors.	Urge incontinence associated with bladder instability. Overflow incontinence associated with outflow obstruction.
Drugs:		
Propantheline (Probanthine) Imipramine (Tofranil) Oxybutrin (Ditropan) Flavoxate (Urispas)	Diminish bladder contractions.	Urge incontinence associated with bladder instability.
Ephedrine (Sudafed)	Strengthen bladder outlet	Stress incontinence associated with sphincter weakness.

Table 7.—Treatments for Urinary Incontinence—continued

Examples	Mechanism	Uses
Phenypropronolamine (Ornade)		
Estrogen (Premarin) Oral or topical	Increases supporting tissue around urethra.	Stress incontinence.
Bethanechol (Urecholine)	Promotes bladder contraction.	Overflow incontinence.
Training procedures:		
Habit training	Caretaker determines individual's pattern of incontinence and gets him/her to toilet accordingly.	Urge. incontinence. Functional incontinence.
Bladder retraining	Caretaker establishes routine of fluid administration and toileting with progressive lengthening of toileting intervals to increase bladder capacity or re-initiate normal voiding.	Urge incontinence. After catheter use. Overflow incontinence after overdistension injury.
Pelvic floor exercises	Exercises to strengthen pelvic muscles.	Stress incontinence.
Biofeedback	With specialized equipment, patient is trained to inhibit bladder contractions or contract pelvic muscles.	Mainly urge incontinence associated with bladder instability and stress incontinence associated with sphincter weakness.
Behavioral modification	Caretaker rewards incontinent individual for staying dry.	Incontinence associated with underlying mental or emotional disorders; some forms of functional incontinence.

SOURCE: J. Ouslander, R. Kane, S. Vollmer, and M. Menezes, "Medical Devices for Urinary Incontinence: A Case Study," prepared for the Office of Technology Assessment, contract No. 333-6550, December 1983.

DEVICES

Four major types of devices are currently in use: bedpads and undergarments, catheters, electrical stimulation, and artificial sphincters.

Bedpads and **undergarments** range from those that are completely disposable to those with launderable components. Most acute care hospitals and long-term care institutions use "blue pads" for managing incontinence despite their relatively low absorbency and lack of odor control. More innovative forms, like the Kylie© pad that is launderable and draws moisture away from the body, have been marketed widely in the United States only recently. The efficacy of these products in diminishing complications of incontinence such as skin irritation and urinary tract infection has not yet been carefully assessed.

The three types of **catheters** commonly used are chronic indwelling catheters, intermittent bladder catheterization, and, for men, external catheters. A chronic indwelling catheter is placed in the bladder and attached to plastic tubing that drains urine into an externally worn collection bag. This type of catheter can induce serious complications, however; urinary tract infection is the most common. It should only be used in patients with urinary retention that cannot be treated surgically, pharmacologically, or by intermittent catheterization, and for patients with skin conditions that are worsened by contact with urine.

There is evidence that indwelling catheters are overused in managing urinary incontinence, especially in elderly patients in long-term care facilities (10 to 30 percent of incontinent cases), probably because of the relatively low cost and convenience for the staff (50,53,57,61,69). Intermittent self-catheterization has a lower incidence of infection and other complications in younger patients (51), although its relative efficacy in the elderly has not been studied; this method also requires training on the part of the caregiver and/or patient. External (condom) catheters, used exclusively in men, may reduce infection but require frequent changing, often fall off, and may result in local skin irritation.

The National Aeronautics and Space Administration (NASA) has also developed an external female urine-collection device for use of women astronauts. This and a similar adhesive device developed by private industry are still in the developmental stage for application to older women in the general population; both have already received approval by the Food and Drug Administration (FDA). The adhesive device has been marketed on a limited basis; the NASA product is scheduled for release onto the retail market in November 1984 under a nonexclusive licensing agreement with a small manufacturing company headed by the inventor of the device.

Electrical stimulation involves an external device that intermittently stimulates musculature associated with voiding to induce muscle contraction and maintain continence. This technique is most useful for incontinence due to stress and bladder instability (40,41,42,43). Between 50 and 80 percent of individuals treated in this way derive some short-term benefit from the treatment. The long-term effects of chronic electrical stimulation are unknown, however, and the patient must be willing and able to manage the device.

While **artificial sphincters** appear to improve or cure incontinence in 40 to 80 percent of patients treated (relatively few patients receive such implantations), there are several associated complications. The most common problems are erosion of the sphincter cuff into the urethra, persistent infection, and mechanical failure. Favorable results have been obtained with prostheses consisting of injections of silicone gel or Teflon®, but there is again the risk of urethral erosion and Teflon® particles have shown a tendency to migrate to other major body organs.

SURGERY

Surgery is an essential treatment for certain types of incontinence and is effective, but not essential, for other types. An anatomic obstruction to urine flow (e.g., an enlarged prostate in men), for example, can lead to recurrent infection and even renal failure, necessitating surgery to relieve the obstruction. Yet surgery may not cure the incontinence and may even induce a different type of incontinence. Pathologic conditions in the lower genitourinary tract that irritate the bladder or urethra (e.g., bladder tumors, bladder stones, and diverticuli of the urethra or bladder) and cause incontinence can also be treated surgically. The most common surgical procedure for incontinence is bladder-neck suspension in women in which the bladder neck and urethra are repositioned to relieve stress incontinence. The success rate is generally reported as 70 to 90 percent (54,62,63,65,66). There have been no conclusive studies on the efficacy of surgery relative to other treatments for stress incontinence.

DRUG TREATMENT

Although drugs can be used to treat overflow, stress, and urge incontinence (36,56,64), they may be inappropriate for the elderly or have undesirable side effects. For example, cholinergic drugs used to treat overflow incontinence that promote bladder contraction may actually worsen incontinence in the elderly by creating urinary frequency and urgency; in addition, some of these drugs may cause cramping, diarrhea, and increased bronchial secretions. Drugs used to treat stress incontinence that promote muscle contraction around the bladder outlet may exacerbate hypertension. The topical and oral estrogens that are used in elderly women to strengthen the tissues around the bladder outlet may also exacerbate hypertension and increase the risk of cancer of the uterine lining. The most common and effective drug treatment involves substances that reduce bladder contraction to treat urge incontinence. Most studies show these drugs to be effective in 50 percent of the patients. Many, however, can have undesirable side effects, including dry mouth, constipation, and blurred vision. Unfortunately, there have been few studies comparing the efficacy of these drugs with other methods.

TRAINING PROCEDURES

"Training procedures" are broadly defined here to include pelvic-floor exercises, biofeedback bladder retraining, habit training, and behavior modification. Many of these have been reported as successful in managing various types of incontinence (47,71). Patients must have adequate cognitive function to use the pelvic-floor exercises (strengthening associated muscles by repeated contraction), biofeedback bladder retraining (learning to control muscle contraction, requiring specialized equipment and personnel) or bladder retraining (learning progressively to extend periods between voiding). Habit training involves developing a toilet schedule and can be used with patients who have mental and physical impairments. Behavior modification is similiar to habit training but incorporates positive and negative reinforcers and is used mainly for bed-wetting children and chronically mentally ill patients (39,60). Most studies of the efficacy of training procedures have involved some type of bladder retraining or habit training for urge incontinence and have found 50 to 80 percent of subjects cured or substantially improved (44,45,47,48,49,52). Again, there have been few studies of the relative efficacy of training compared with other treatments.

The cost of incontinence

The costs of incontinence go far beyond economic considerations. Withdrawal from social activities, psychological distress, burden on the family and caregivers, and the influence on the decision to institutionalize are all important potential effects of incontinence that are difficult to quantify (55). In one study of stress in caregivers of frail elderly community-dwelling persons, difficulties with toileting and incontinence were highly correlated with caregiver burden (55). Since the Federal Government plays an important role in assisting with medical costs, however, it is important to discuss the cost of incontinence and current Federal reimbursement policies.

The variety of incontinence products are discussed in detail in a separate OTA case study, "Technologies for Managing Urinary Incontinence." One of the report's major conclusions is that promotion of these products has been targeted largely toward physicians and other health care professionals rather than toward the consumer. As a result, incontinence products are not widely available at the retail level and public awareness of the variety of treatments available is scant.

Two large paper-products firms have entered the market for disposable incontinence products, however, and have launched consumer-oriented advertising campaigns that may help destigmatize incontinence and lead to competitively low prices. Unfortunately, these promotional efforts, which emphasize management of incontinence through the use of undergarments, may lead consumers to believe that this is the most appropriate treatment. For other technologies such as catheters, electrical stimulators, and artificial sphincters, the delays and difficulties in obtaining FDA approvals could constitute a barrier to entry into the market for manufacturers. The case report points out that the Federal Government, as a disinterested party, could effectively promote consumer education about the importance of medical evaluation and the variety of treatments available.

FINANCIAL COSTS

The actual expense of incontinence management and the Federal role in providing financial assistance to care recipients is important since this can affect access to health care. Moreover, loss of productivity of both those afflicted and their caregivers can be substantial. It is important to note that, as has been mentioned, very few incontinent nursing home patients receive a specific evaluation of their condition. Although an extensive urologic evaluation for incontinence can be costly (about $600) and involve highly specialized personnel and equipment, it may save money overall by curing or mitigating the condition through more specific, effective treatment (58), and bring immeasurable improvement to the quality of life of both the patient and the caregiver. Research into the most practical and cost-effective methods of diagnosing different types of incontinent patients is sorely needed.

The U.S. Surgeon General has estimated that $8 billion is spent on incontinence in this country annually (37); the basis of this estimate has not been detailed, however. A recent report (58) divides estimates of the overall annual costs of incontinence in nursing homes in the United States into "first-order costs" (i.e., the costs of managing incontinence without the costs of any complicating conditions) and "second-order costs" (i.e., the costs associated with managing complications of incontinence and its treatment).

If only first-order costs are considered, incontinence adds between $3 and $11 to the daily cost of caring for a nursing home patient. The range of cost is due to differing costs of various management techniques. Of the three components of these costs (labor, laundry, and supplies), the labor involved in handling an incontinent patient is the major contributor.

Assuming that there are approximately 600,000 nursing home patients with some degree of urinary incontinence and that, in three-quarters of these patients, the incontinence is of sufficient severity that catheters or other specific management techniques are used, the yearly first-order costs of incontinence in U.S. nursing homes can be estimated at between $0.5 billion and $1.5 billion. This represents between 3 and 8 percent of the total expenditure on nursing home care in this country (58). The costs of incontinence in the community are much more difficult to estimate and no studies have addressed these costs in detail.

First-order costs were estimated to be lowest for patients with indwelling catheters. Yet for these same patients the second-order costs were highest because of the high incidence of urinary tract infection associated with continuous use of these devices. A conservative estimate of the second-order costs of incontinence is between $2,000 and $3,000 per patient per year. The National Institute on Aging is currently funding a study on methods to reduce complications associated with indwelling catheters in order to reduce second-order costs and possibly render these catheters less costly alternatives to other treatments in the nursing home setting.

PAYMENT

Except for diagnostic evaluation and services delivered as part of an acute hospitalization,[3] Medicare coverage for incontinence products is quite limited. Part B of the plan only pays for a prosthetic device that replaces an inoperative body organ or function thereof. Thus sphincters or ileostomy bags would qualify, but catheters, bedpads, and undergarments would not. Medicare also does not pay for most bedpads and undergarments used outside of the hospital.

Coverage for urinary incontinence products under Medicaid varies from State to State. Undergarments and other disposable products are least likely to be considered medical equipment and are therefore the least likely treatments to be covered. Medicaid covers these products in some States, such as New York, California, Florida, Illinois, and Michigan. In other States, such as New Jersey, these products are not covered. Even in those States in which Medicaid covers the products, the type and extent of coverage vary considerably. Furthermore, State requirements for coverage and payments change frequently.

Given present fixed reimbursement rates in most States, the first-order costs of incontinence ($3 to $11 per day) represent 7 to 27 percent of the daily per diem provided by Medicaid (about $41 per day in California for 1984). The result is often reluctance of nursing homes to accept incontinent patients. Several States have developed or are developing case-mix reimbursement strategies that recognize the rising costs of incontinence; the emphasis, however, is on managing such patients rather than on treatment to improve their condition.

Moreover, second-order costs, as for treatment of skin breakdown or urinary tract infection, are largely covered by Medicare. The financial incentive for nursing homes is therefore to use the cheapest treatment in terms of first-order costs (e.g., an indwelling catheter) regardless of possible resultant complications. An experiment conducted by the National Center for Health Services research is currently testing the effects of paying nursing homes an incentive to accept incontinent patients and a bonus if they improve their functional condition (70).

Conclusion

Urinary incontinence afflicts a significant percentage of our elderly population with detrimental effects on their physical health, psychological well-being, and social functioning, and constitutes a costly health care problem. There are several barriers to effective treatment, including lack of knowledge about the most effective treatment for particular types of incontinence, lack of public awareness of the variety of technologies available

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[3] Medicare coverage of acute hospital costs under Part A changed dramatically with the introduction of diagnosis-related groups in October 1983. The all-inclusive price will not specifically pay for an incontinence device.

(many curative), social stigma, and limited access to health care due to minimal, inconsistent government reimbursement for most of incontinence treatments and products, especially for the noninstitutionalized. Improving the quality and availability of treatment for urinary incontinence by reducing or removing these barriers could reduce the impact on affected individuals and their caregivers, as well as reduce costs through decreased institutionalization and reduced use of other health care resources.

Hearing impairment in the elderly[4]

Hearing loss is a major problem for the elderly. National surveys show that hearing impairment is the third most prevalent chronic condition among the noninstitutionalized elderly, exceeded only by arthritis and hypertensive disease (93,94).

As the older population grows, the number of hearing impaired individuals will increase rapidly. Because the over-75 population has a very high prevalence of hearing impairments and is growing at a faster rate than the elderly population as a whole, the total number of hearing impaired elderly individuals will rise dramatically. At present, more than 7 million elderly persons have significant hearing impairments. If current rates persist, there will be more than 10 million hearing impaired elderly persons by the year 2000.

Hearing impaired individuals include both those who are deaf and those who are hard of hearing. **Hard of hearing** refers to a degree of hearing impairment that interferes with comprehension of speech, although partial auditory function remains. **Deaf** refers to a degree of impairment that renders hearing nonfunctional for the ordinary purposes of life (90).

Only a small proportion of the elderly with hearing impairments are deaf, but even the partial loss of hearing that is often associated with aging can limit independence and negatively affect quality of life for the elderly. Hearing loss restricts the individual's ability to interact with others and to give, receive, and interpret information. Sound is important for self-protection and identification of hazards in the environment. Ultimately, hearing loss can affect mental and physical health, decreasing the ability of some individuals to function independently and increasing the need for formal and informal long-term care services.

Prevalence

The prevalence of hearing impairment is measured by two methods, interviews and audiometric testing. The interview method underestimates the prevalence of hearing impairment because many individuals, particularly the elderly, are not aware of their hearing loss or may deny or minimize its severity. Audiometric testing results in more accurate information about prevalence and also measures hearing at specific frequency levels; this is important because hearing acuity in the elderly varies greatly according to frequency. Audiometric tests that measure hearing of pure tones, however, underestimate the extent of *dysacusis*, a condition that is widespread among the hearing impaired elderly. Individuals with dysacusis can hear pure tones but have difficulty understanding speech because of deficits in auditory discrimination (84).

Prevalence of hearing impairment by age, gender, race, income, and institutional status is discussed here. These data reflect prevalence of hearing impairment in the total population but may not apply in a given geographic area. For example, the prevalence of chronic ear infections among certain ethnic groups in Alaska and in the Southwest increases the prevalence of hearing impairment in these areas. Similarly, in areas where high-noise industries are concentrated, hearing loss is much more prevalent among the working age and older populations.

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[4] This section summarizes an OTA background paper, *Management of Hearing Impairment in the Elderly,* which draws heavily on G. Becker, R. M. Flower, L. E. Glass, and R. J. Newcomer, *The Management of Hearing Impairment in Older Adults* and American Speech-Language-Hearing Association, *Management of Hearing Impairment in Older Adults,* OTA contract No. 333-8970.0, 1984.

AGE

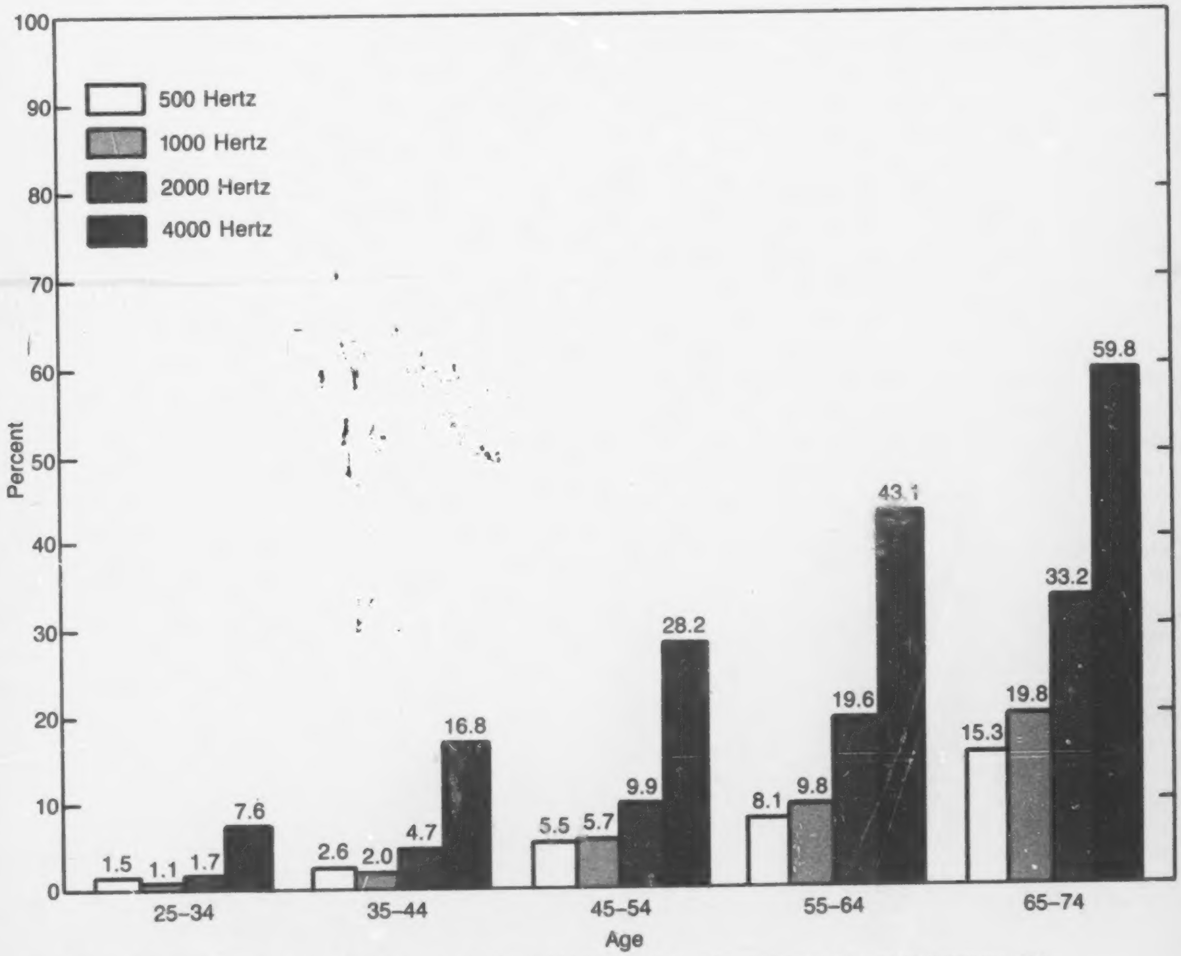
Interview surveys indicate that the prevalence of hearing impairment rises sharply with age, from less than 2 percent of those under 17, to about 12 percent of those 45 to 64, 24 percent of those 65 to 74, and about 39 percent of those over 75 (92). The severity of hearing impairment also increases with age (91).

Audiometric testing indicates that hearing impairment varies according to the frequency of the sound. As figure 13 indicates, the elderly have much greater hearing loss for high-frequency than low-frequency sounds. While most speech is in the frequency range of 500 to 2,000 hertz, sounds such as S, T, K, and P are heard at higher frequencies, and elderly persons with hearing impairments are often unable to hear these sounds.

GENDER

Interview surveys show that elderly men have a higher prevalence of hearing impairment than elderly women. For example, one study found that 29 percent of men ages 65 to 74 had hear-

Figure 13.—Percent of Adults Aged 25 to 74 With Hearing Impairment, by Frequency of Tone in the United States, 1971-75.



SOURCE: National Center for Health Statistics. Basic Data on Hearing Level of Adults 25-74; Office of Health Research Statistics and Technology, 1980.

ing impairments compared with only 20 percent of women in that age group. Among those over 75, 44 percent of men but only 35 percent of women have hearing impairments (92). Some scholars suggest that these differential rates result from men's longstanding exposure to noise in heavy industry and other work-related situations.

Audiometric testing indicates that elderly men have a higher prevalence than women of hearing loss at high frequencies. One study showed that 49 percent of men over 65 had a moderate to severe hearing loss at 4,000 hertz, compared with only 17 percent of women over 65. Elderly women, however, have a slightly higher prevalence of hearing loss at low frequencies (95). The reasons for these differences are not known.

RACE

Interview surveys indicate a lower prevalence of hearing impairment among black persons of all ages than among whites. For example, blacks age 65 to 74 (both sexes) showed an impairment rate of 18 percent, while whites in the same age group showed a rate of 25 percent (92). Audiometric testing shows that elderly blacks have a lower prevalence of severe hearing impairments than elderly whites, but a higher prevalence of moderate hearing impairments (95).

INCOME

Persons with low family incomes have higher rates of hearing impairment than their wealthier counterparts. For example, one interview survey found that the rate of impairment among persons 65 to 74 with annual family incomes below $3,000 was 30 percent. For the same population group with incomes in excess of $15,000, the rate was 20 percent. With only minor variation, this inverse relationship to income is sustained for all age categories (92).

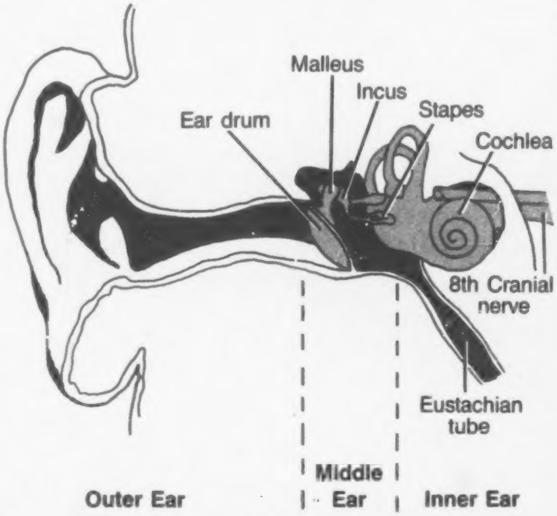
INSTITUTIONALIZATION

The prevalence of hearing loss among the institutionalized elderly is greater than among the noninstitutionalized elderly (88). Moreover, a recent study of an institutionalized older population (80) pointed out the inadequacy of self-reports for accurately assessing hearing impairment. Residents of a home for the aged were interviewed about their hearing and were given audiometric tests. Fifty percent of the residents acknowledged a hearing loss, but audiometric testing showed that 75 percent had hearing impairments; 8 percent of the residents reported hearing loss when there was no audiometric evidence of impairment, while 33 percent reported normal hearing but actually had clinically significant loss. These findings suggest that audiometric testing should be a routine procedure for elderly individuals admitted to long-term care facilities.

Types and causes of hearing loss among the elderly

Types of hearing impairment include conductive, sensori-neural, mixed, and central hearing impairments. These types are based on the site of structural damage or blockage (see fig. 14). *Con-*

Figure 14.—Physiology of the Human Ear



In the healthy ear, the outer ear gathers sound waves and directs them to the ear drum, where three bones—the malleus, incus, and stapes—transmit the vibration to the cochlea. In the cochlea delicate hair cells translate the vibration into electrical current that passes through the 8th cranial nerve to the auditory centers of the brain.

SOURCE: OTA. From an original by V. Friedman, Washington University Medical Center at St. Louis.

ductive hearing impairment involves the outer and/or middle ear. *Sensori-neural* impairment involves damage to the inner ear, the cochlea, and/or fibers of the eighth cranial nerve. A *mixed hearing impairment,* as the term implies, is one that comprises both conductive and sensori-neural components. A *central processing disorder* is a hearing impairment that influences the understanding of spoken language; the elderly person may hear the words but be unable to make sense out of them as a result of disorders of the auditory pathways in the brain.

Hearing impairment causes an inability to hear environmental sound without amplification. Hearing impairment is sometimes also characterized by an inability to discriminate or understand speech sounds even with amplification. **This distortion of sound, which is common among the hearing impaired elderly, can result in the complaint, "I can hear you, but I can't understand you."**

Tinnitus is often an accompanying complaint of those who have hearing loss. It is a ringing or buzzing in the ears or head, the cause of which is unknown. The prevalence of tinnitus increases with age, and is more common in women than men (84). Another problem often seen in older persons with hearing loss is *recruitment,* an inability to tolerate loud sounds. This condition can interfere with satisfactory use of a hearing aid.

Causes of conductive and sensori-neural hearing loss are listed in table 8. The most common type of hearing loss in the elderly is prebycusis, a sensori-neural loss resulting from changes in the inner ear. These changes can include decreased numbers of hair cells or nerve fibers in the cochlea and fibrous changes in the small blood vessels that supply the cochlea. Some researchers believe that presbycusis is associated with normal aging, while others believe it results primarily from disease conditions. Not all elderly individuals have presbycusis, and some people in their 90s and older retain acute hearing.

THE ONSET OF HEARING IMPAIRMENT

The onset of hearing impairment can occur before birth or in early childhood before language is acquired, during early or middle life, or during later life. People who have been deaf since childhood have had time to adjust to their hearing losses and to develop behaviors to cope with the social isolation resulting from deafness (77), but additional problems acquired late in life may seriously affect their functioning. For example, poor vision in old age may interfere with lipreading techniques the individual has used successfully throughout life.

Table 8.—Causes of Conductive and Sensori-Neural Hearing Impairments

Causes of conductive hearing impairments:

External blockage: buildup of wax or presence of a foreign object in the ear, which is very common in the elderly.
Perforated eardrum: a hole or tear in the eardrum, which can occur as a result of injury, sudden pressure change, or infection.
Genetic and congenital abnormalities: malfunction and/or malformation of the outer and/or middle ear.
Otitis media: middle ear infection and accumulation of fluid.
Otosclerosis: disease process affecting the mobility of the middle ear bones, which is thought to be hereditary.

Causes of sensori-neural hearing impairment:

Presbycusis: literally, "old hearing." The term has been used to describe hearing impairment that occurs with old age. Presbycusis may be sensory, neural, metabolic, or vascular in nature.
Hereditary hearing loss: includes a great variety of disorders that affect the sensori-neural mechanism and are usually present at birth.
Trauma-induced: caused by a severe blow to the head, an accident, or a stroke or brain hemorrhage that affects the ear, auditory pathways, and brain centers.
Tumors: acoustical neuromas and tumors that invade the eighth nerve.
Noise damage: brief or continued exposure to high-intensity sound, which irreparably damages the hair cells.
Vascular incidents: related to hypertension, heart disease, or other vascular problems that may alter blood flow to the inner ear.
Drug-induced hearing loss: drugs such as aspirin, and some antibiotics, diuretics, and certain powerful anti-cancer drugs can damage the hair cells or other vital parts of the inner ear.
Viral and bacterial illness: such as mumps, meningitis, or encephalitis, and rubella contracted by expectant mothers, are some common disease processes that are well-documented as etiologies for hearing impairment.
Meniere's disease: characterized by fluctuating hearing loss, dizziness, and tinnitus, the possible causes range from allergy to hypothyroidism and diabetes.

SOURCE: American Speech and Hearing Association, "Management of Hearing Impairment in the Elderly," prepared for OTA under contract No. 333-8970.0, 1984.

The elderly who become hearing impaired late in life present different problems because they must acquire an entirely new and complex system of communication in order to maintain social interaction. Little information is available about the special problems of acquired hearing impairment among adults, and particularly the elderly.

Impacts of hearing impairment

Hearing impairment causes social and psychological difficulties by interfering with the individual's ability to communicate with family and friends. This can lead to withdrawal, social isolation, and depression. Loss of hearing interferes with the elderly person's ability to compensate for other losses that can occur with aging, such as loss of relationships due to the death of spouse, siblings, and friends, loss of a familiar home or community, and worsening health and mobility. Lack of easy communication means decreased access to new people, new activities, and new services.

Hearing impairment limits access to information that is normally available through personal communication, telephone, radio, and television. For elderly individuals who have both hearing and visual impairments, access to information is often severely limited, and some research indicates that restricted access to information can contribute to the progressive development of confusion; further research is needed in this area.

Perhaps more important than any actual confusion related to hearing loss is the widespread *assumption* that elderly persons who are hearing impaired are also confused. In a study conducted in a hospital, health care professionals described their impatience with elderly persons with hearing losses. Several respondents said the method they used in interactions was to "scream at them." This behavior was considered acceptable since the patients were old, "and probably senile, too" (76).

DENIAL OF HEARING IMPAIRMENT

Many elderly individuals deny they have a hearing problem despite significant evidence to the contrary. Negative social attitudes about hearing impairment and growing old encourage denial. **Hearing impairment is not visible, and invisibility facilitates denial.** In addition, hearing impairment in the elderly is often characterized by very gradual onset that can make the impairment difficult to recognize.

For elderly persons with one or more life-threatening illnesses, hearing impairment may seem insignificant by comparison. The onset of depression and withdrawal associated with hearing impairment may be slow and insidious and may appear unrelated to hearing loss. Accidents that occur as a result of the elderly person's inability to receive aural cues are frequently ambiguous as to cause. Similarly, difficulties in communication and social relationships may not be attributed to hearing loss, even when the loss is acknowledged. As a result, hearing impairment is often not seen as important by the elderly, their families, and health care providers. Denial of hearing impairment and failure to recognize its impact on independent functioning are clear obstacles to effective treatment.

Treatment of hearing impairment

Treatment of hearing impairment includes methods to: 1) prevent hearing impairment or reduce its severity, 2) improve the individual's communicative competence through amplification or other electronic and mechanical devices, 3) adapt public facilities to accommodate the special needs of hearing impaired people, and 4) help people to manage their hearing problems by providing information about devices and other compensatory strategies to reduce communication handicaps.

Potential treatments for hearing impaired people are the same regardless of age. The suitability and effectiveness of each approach, however, differs considerably among the various age groups, because of the type of hearing loss most frequently encountered and because of other physical, psychological, and social characteristics of each age group.

PREVENTION

Prevention is an obvious first approach to treatment. At present, too little is known about the causes of hearing loss associated with aging to allow effective preventive measures. Dietary factors and circulatory changes have been implicated, if not as direct causes, at least as accelerators of deterioration in the auditory system. More vigorous research efforts might identify specific factors that would ultimately lead to precise prevention strategies.

Some hearing impairments in older people result from preventable problems that began earlier in life, such as untreated infections and exposure to noise. Better health care throughout life and effective noise control procedures could ultimately reduce the prevalence and severity of hearing loss among older people.

Some drugs damage auditory mechanisms. The best known ototoxic drugs are the "aminoglycosides," a class of antibiotics that includes streptomycin; these drugs may be lifesaving but can adversely affect hearing. Aspirin can also be ototoxic, though probably only in the high dosage levels sometimes used in the treatment of arthritis. Aspirin-induced hearing loss is usually reversible if it is recognized early and dosage is reduced. Too little research has been done on the mechanisms of ototoxicity and the essential chemistry of ototoxic agents. Educational efforts have been effective in informing most physicians of the hazards of streptomycin, but the ototoxicity of other drugs is frequently not recognized.

MEDICAL AND SURGICAL TREATMENT

The likelihood of curing hearing impairments in the elderly with available medical or surgical treatment is limited because they are almost always sensori-neural losses, most of which are currently not treatable. The exceptions include removal of acoustic tumors, and surgical treatment of Meniere's disease.

The *cochlear implant* is a relatively new treatment for sensori-neural hearing loss. This electronic device is surgically implanted in the inner ear to pick up sound waves, change them to electrical signals, and carry them past the cochlea to the auditory nerve (82). The purpose of the implant is neuroelectrical simulation of natural hearing, but full attainment appears far in the future. The sound produced by available implants has been described as fluctuating grating noises and buzzes that are not the same as normal sound (85), and users need extensive training to learn to interpret the sound. Research to improve the cochlear implant continues in the United States and other countries.

In its present form, the cochlear implant is not appropriate for most elderly hearing impaired people who usually have partial hearing loss rather than the profound deafness for which the device is now used. In the future, as the cochlear implant is improved through research and testing, it may become an important treatment option for sensori-neural hearing loss among the elderly.

TECHNOLOGIES TO COMPENSATE FOR HEARING IMPAIRMENT

Since only a small proportion of the hearing impaired elderly can benefit from medical or surgical treatment, other approaches to treatment are needed. These approaches do not change the underlying condition but provide methods to compensate for hearing loss and maintain adequate communication. Such methods include the use of personal listening devices and amplification systems, adaptations of the telephone system, and signaling and alarm systems.

Hearing Aids.—Hearing aids are amplification devices designed to compensate for partial hearing loss. They have benefited thousands of individuals, allowing them to function in communication situations that otherwise would have been impossible. Yet only about 13 percent of all persons with hearing impairments use hearing aids. The elderly are more likely to use hearing aids than younger people: about 20 percent of all hearing impaired persons over 65 use hearing aids, and those with more severe impairments are more likely to use them (91).

Deterrents to the use of hearing aids include problems in instrument design and performance, social and psychological factors, and cost. Hearing aids do not restore normal hearing for most users. The quality of sound is mechanical, and the amplification of distracting background noise is a problem for users of all ages.

Some specific hearing deficits that are common in the elderly, such as more severe hearing loss at high frequencies and distortion of sound due to abnormalities in the sensory cells, require tailoring of the hearing aid's operational specifications. Sound processing techniques are available to make these adaptations, but most of these techniques are not widely used, partly because of the difficulty of identifying the precise deficits experienced by each individual (85). Audiologists are trained to evaluate hearing deficits, but many elderly individuals buy hearing aids from hearing aid dealers without seeing an audiologist. Moreover, even when a comprehensive evaluation is done, the audiologist or hearing aid dealer may have difficulty selecting the appropriate hearing aid because of the lack of reliable technical information about different brands and types of hearing aids (79).

Social and psychological factors that discourage use of a hearing aid include reluctance to call attention to the hearing impairment and disappointment with the quality of sound provided by the hearing aid. Individuals who once had normal hearing often expect that a hearing aid will return their hearing to normal, and the disappointment they experience in trying to adjust to a hearing aid can create significant acceptance problems. Some experts believe that the elderly have more difficulty adjusting to hearing aids than younger people because of so-called age-related inability to adjust to something new, but it is also possible that many elderly individuals are not using their hearing aids because the aids are inappropriate for their hearing impairments.

Other Personal Listening Devices.—Three other personal listening devices can compensate for hearing loss: audio loop systems, FM amplification devices, and infrared amplification devices. These devices transmit sound directly from the source to the listener, thus eliminating background noise that interferes with hearing. They have been used primarily in classrooms and public facilities, such as theaters and churches, and are often called "large room systems," but they are now being used by individuals for interpersonal communication and TV and radio listening. This use is particularly appropriate for the elderly because they usually have partial rather than complete hearing loss, and in many cases these devices can provide satisfactory amplification. Moreover, no training is needed to learn to use these devices. Audio loop systems, FM amplification devices, and infrared amplification devices can also be used with the hearing aid to eliminate bothersome background noise.

The Use of Devices for Public Access: The Rehabilitation Act of 1973 prohibits discrimination against disabled individuals by any program, activity, or facility receiving Federal assistance. The law requires that these facilities be accessible to people with all kinds of handicaps, including hearing impairment, but the emphasis has primarily been on adapting facilities for people with mobility problems. This has occurred even though the costs of providing access to the hearing impaired with technologies such as FM and infrared amplification devices are usually minimal compared with the costs of major modifications in architecture. **While public funding has been available for architectural modifications, the costs of improved accessibility for the hearing impaired have been paid primarily by the private sector.**

Telecommunications Systems.—Inability to use the telephone is one of the most common problems of hearing impaired individuals. For the elderly, particularly the great number who live alone, the telephone is a link to the outside world; inability to use the telephone can compromise safety and interfere with independent functioning.

Hearing over the telephone is difficult even for those with mild hearing loss because telephone signal transmissions omit very low- and high-frequency sounds that are important for understanding speech. Line noises and other sound distortions also interfere with the quality of sound transmission. In the future, as the need grows to transmit more conversations over limited channels, this problem may become worse. Methods for increasing channel capacity involve omitting parts of the speech message that are considered unimportant, but the standards for what is unimportant are based on the hearing ability of younger persons with normal hearing. Research is needed to document the effect of these omissions on the hearing ability of elderly and other hearing impaired individuals (78).

Devices to assist hearing impaired individuals to use the telephone include amplifiers that can be built into the telephone handset or attached to the side of the telephone, and telecoils that are built into hearing aids to pick up electronic signals directly from the telephone receiver, bypassing the hearing aid microphone. The Telecommunications for the Disabled Act of 1982 requires that all telephones installed in "essential places" such as hospitals, hotels, and similar public facilities be compatible with hearing aids. Because there are no comparable requirements for hearing aids, however, aids can now be sold that are not compatible with these telephones.

For individuals with severe hearing impairments, other devices are available or in the development stage. These devices include:

- teletypewriters (TTYs) that allow individuals to type a message that is carried over phone lines,
- *Teletex* and *Viewdata* information retrieval systems for transmitting text and simple graphics to a television receiver, and
- *Picturephone* and *Vistaphone* devices that transmit a visual image of the speaker over an ordinary telephone line and allow communication through lipreading or manual sign language.

It is not known how many elderly individuals use or could use these devices. The TTYs and Viewdata systems require that the speaker type all messages. The Picturephone and Vistaphone are only helpful to those who communicate through lipreading or sign language. Since few elderly individuals use these methods of communication, the usefulness of these devices for the hearing impaired elderly is limited.

The development of effective computerized speech recognition systems could greatly simplify telephone use for the hearing impaired. These systems convert spoken words into printed output that could be displayed on a screen attached to the telephone. Currently available speech recognition systems have major limitations: they recognize only a few words and sometimes confuse words, and their performance varies widely from speaker to speaker. Future refinements of this technology could facilitate telephone use for the hearing impaired elderly.

Signaling and Alarm Systems.—Signaling and alarm systems that convert sound to visual or tactile signals are important for the safety and independence of hearing impaired persons. Flashing lights and vibrating devices that signal the ringing of a fire alarm, smoke alarm, telephone, doorbell, or alarm clock substitute for sounds the person cannot hear. *Tactile Paging Devices* use radio signals to generate vibrations in a portable receiver carried by the hearing impaired individual.

One serious block to use of these devices by the elderly is lack of awareness of devices that could be helpful. Information about these devices is available within the informal deaf community, which is primarily comprised of younger individuals who have been deaf since childhood or early adulthood, and their families. The elderly, however, are seldom part of the informal deaf community, so they lack access to this source of information. Since the elderly usually do not receive comprehensive aural rehabilitation services, they do not learn about available devices from hearing specialists.

Aural Rehabilitation.—Aural rehabilitation services are designed to help individuals communicate more successfully with or without the use of a hearing aid or other personal listening device. These services are usually provided by audiologists and are briefly described here:

- *Hearing aid orientation* includes instruction in the care and maintenance of the aid and earmold, practice inserting the earmold and batteries, and instruction in the use of amplification in a variety of listening situations.
- *Auditory training* involves systematic training in the use of residual hearing. The individual is taught to recognize and differentiate sounds and intonational patterns that give clues about the content and meaning of speech. This training is presently used almost exclusively with children, but the elderly, who usually have some residual hearing, could also benefit from this approach.
- *Speechreading* is the use of visual cues to facilitate understanding speech. It is similar to lipreading but involves attention to facial,

throat, and body positions in addition to lip movements (81,87). Few elderly individuals are taught speechreading techniques, even though these techniques are particularly effective for individuals who have only partial hearing loss. *Cued speech* is a method of communication that supplements speechreading and is being used with elderly individuals in a few places in the United States. Cued speech involves the use of hand signals and hand positions that clarify the lip and facial positions associated with speech sounds.

- *Counseling* can address negative attitudes that interfere with rehabilitation. It can help to develop strategies to manage social situations and other life activities in ways that will lessen the handicap (81). The elderly are particularly likely to believe that their hearing losses are hopeless, and some elderly individuals suggest that services be directed toward a younger person who could derive greater benefit. Counseling can help to overcome these feelings.

Despite the potential benefits of aural rehabilitation, few elderly individuals receive these services. Reasons for this include lack of awareness of the value of the services by the elderly and their families, the cost of the services, and the historical focus of hearing professionals on the needs of profoundly impaired children.

Environmental Design.—Building design characteristics affect the behavior of sound and the relative ease or difficulty of hearing. For example, hard-surfaced walls and floors reflect sound, creating reverberations that interfere with hearing, while sound-absorbent wallcovering materials decrease reverberations (83). While much is known about design characteristics that affect hearing, this information is seldom applied in buildings used by the elderly. Reduction of reverberations and background noise in these facilities could ameliorate some of the problems of those with hearing loss.

The service delivery system

SERVICE PROVIDERS

Hearing services for the elderly are provided primarily by physicians, audiologists, and hearing aid dealers. Although few hearing impairments of older people respond to medical or surgical treatment, some elderly persons see a *primary care physician* as a first step in treatment. Depending on their symptoms, they may be referred to a specialist, who is usually an *otolaryngologist*. Physician evaluation is important to identify impairments that are medically treatable, but physicians usually receive little training in the management of hearing impairments and alternative approaches to compensate for hearing loss.[5]

Audiologists are nonmedical specialists trained in the identification and evaluation of hearing impairment and rehabilitation of individuals with hearing deficits. Audiological evaluation includes assessment of hearing threshold sensitivity, speech discrimination ability, and residual auditory function. Audiological testing helps to determine the type of hearing aid needed, and some audiologists dispense hearing aids. Audiologists also provide hearing aid orientation and counseling for hearing impaired persons, families, and health care providers in a variety of settings.

Hearing aid dealers sell hearing aids and hearing aid accessories, such as batteries, earmolds, and spare cords, and may also repair hearing aids. They often receive as little as 1 week's training from hearing aid manufacturers and much of this training focuses on sales management.

The National Hearing Aid Society (NHAS) offers a 20-week home-study course, but many dealers do not take the course. Moreover, an expert panel review of the home-study course found many deficiencies including incorrect, oversimplified, and outdated information. The review panel concluded that the home-study course was "*not only inadequate but potentially dangerous*. It is dangerous in the same way that 'quack' medicine is dangerous . . . it postpones or prevents adequate evaluation, diagnosis, and treatment of hearing loss and its accompanying pathology" (89).

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[5] Otolaryngologists receive some training in hearing measurement techniques and amplification, but few otolaryngologists receive extensive training in sophisticated aspects of auditory processing and its relationship to communicative ability. Their training focuses primarily on medical diagnosis for and medical/surgical treatment of conditions affecting the ear, nose, throat, head, and neck, and on facial, cosmetic, and reconstructive plastic surgical techniques.

The National Hearing Aid Society confers the title "certified hearing aid audiologist" on dealers who pass the NHAS home-study course. This title can lead consumers to believe that the dealer possesses expertise that he does not have. The Federal Trade Commission (FTC) has proposed a rule that would prohibit the dealer's use of the term "certified hearing aid audiologist." The use of this term by dealers is already prohibited in several States.

The most valuable aspect of the dealer's role in the hearing aid delivery system is that of a prosthetic dispenser. Dealers are trained and qualified to make earmold impressions, to fit the final earmold product and the hearing aid for comfort, and to provide hearing aid wearers with *basic* instruction concerning the operation and care of hearing aids. They are generally not qualified to provide the comprehensive auditory evaluation needed by the hearing impaired elderly.

Many elderly individuals enter the service delivery system through a hearing aid dealer. When they are fitted with hearing aids without consulting an audiologist they risk purchasing an aid that is of no value to them.

Speech therapists, social workers, psychologists, nurses, and other caregivers sometimes provide physical, emotional, and "informational" support to the hearing impaired elderly. These professionals often know very little about treatments, devices, and rehabilitative approaches that might ameliorate the hearing loss. The education of *all* human services professionals should include information about the causes and treatment of hearing impairments in the elderly.

FEDERAL REGULATION OF THE DELIVERY SYSTEM

Some aspects of hearing aid sales are regulated by the Food and Drug Administration. The FDA requires that the consumer must give the hearing aid dispenser a written statement from a physician, certifying that the hearing loss has been evaluated and that the individual may be a candidate for a hearing aid. However, consumers who are over 18 may sign a form waiving the requirement of a physician's evaluation. There is no objective information about the number of aids that are dispensed on the basis of these waivers, but it has been informally estimated that in some communities up to 80 percent of all aids are dispensed through waivers.

FDA regulations also require that the customer receive an instructional brochure describing the use and care of the aid, sources of repair and maintenance, and a statement that the hearing aid may be only part of a rehabilitative program that may also involve speechreading or auditory training. The regulations require a warning to dispensers and purchasers that certain conditions make medical consultation advisable prior to purchase of an aid.

While the FDA regulations were intended to address safety and effectiveness, they offer no assurance that any hearing aid that is sold will benefit the purchaser. Furthermore, in providing a waiver for even the requirement of physician evaluation prior to sale, the regulations surrender all semblance of quality control. Regulations that thus purport to offer consumer protection, but do not in fact do so, may be more dangerous than no regulations at all.

During the mid-1970s the FTC initiated a major effort to develop regulations for hearing aid sales. Recommended regulations, published in 1978, included restrictions on in-home sales, marketing of used hearing aids, and the use of testing programs to identify potential customers. The regulation that was most vigorously contested by the hearing aid industry would allow a hearing aid purchaser or renter to cancel the sale or rental within 30 days and receive a refund. These recommended regulations were strongly supported by consumer advocates and organizations for the hearing impaired, but no regulations have been promulgated as of October 1984, a full eight years after the rules were proposed. The FTC is presently sponsoring a survey of hearing aid users, and results of the survey will be used by the commissioners to determine the current need for regulations.

Funding for treatment of hearing impairments

Hearing services for the elderly are paid for by government programs, such as Medicare and Medicaid, private insurance, and direct out-of-pocket payments. Medicare pays for medical and surgical hearing services provided by physicians, and some services provided by audiologists, but only when authorized by a physician. Medicare does not pay for audiological evaluations related to the prescription of hearing aids. Purchase of hearing aids and other assistive listening devices are also not covered by Medicare.

Hearing aids are the most common treatment for hearing impairment in the elderly, and lack of Medicare funding for hearing aids has a severe effect on the provision of effective treatment. Many elderly individuals purchase hearing aids, but few are also willing and able to pay for an audiological evaluation that could specify an appropriate aid. Without this evaluation it is likely that the hearing aid will be ineffective.

Medicaid pays for medical and surgical hearing services provided by a physician to low-income patients. Some services provided by audiologists are covered by Medicaid in most States, and Medicaid pays for hearing aids in about half of the States. A major problem in many States that have Medicaid reimbursement for audiological services and purchase of hearing aids is that the reimbursement rates are so low that providers refuse to serve Medicaid patients. Another problem with reimbursement for hearing services by both Medicare and Medicaid is the complexity of Federal and State regulations that govern reimbursement, especially for audiology services.

Private insurance companies cover some hearing services, but each insurance policy is independently negotiated, and it is difficult to specify exactly which hearing services are covered by which insurers for which groups of beneficiaries. Most policies reimburse for hearing services provided by physicians and some hearing services provided by audiologists, but routine evaluations to detect hearing loss and services related to degenerative hearing loss are not covered. Hearing aid evaluations and hearing aids are also not covered.

Since Medicare and private insurance do not pay for audiological evaluation or purchase of hearing aids or other assistive listening devices, the elderly must pay for these services and devices themselves or do without.

Federal Government programs for the hearing impaired elderly

Hearing impairment among the elderly is a Federal Government concern because of its impact on the safety and quality of life of elderly people and because of the need for publicly funded health and social services for the hearing impaired. Federal initiatives to address these concerns have included funding for research and some hearing services, legislation to guarantee access to public services and facilities for the hearing impaired, and regulation of hearing aids. While these initiatives have benefited hearing impaired individuals of all ages, there is a need for programs that address the specific problems of the hearing impaired elderly.

The prevalence of hearing loss in the elderly far exceeds that of most chronic diseases and disabilities of later life, but the magnitude of this problem has not been reflected in the amount of research that has been conducted in pathology, prevention, treatment, and rehabilitation. Most hearing-related research has been directed toward the most severe hearing problems and particularly the problems of deaf children. In contrast to children, however, hearing impairment in the elderly is often mild or moderate, instead of severe, yet it is very widespread; it is often progressive; it usually has a gradual onset and is frequently not recognized for some time; and finally, hearing impairment in the elderly often coexists with other health problems that complicate treatment and limit the effectiveness of available assistive devices. Research is needed on causes of hearing impairment in the elderly and appropriate treatment methods.

Denial of hearing impairment is a continuing obstacle to treatment. Public education to increase awareness about the extent and type of hearing impairments among the elderly is needed.

Few of the hearing impairments of the elderly respond to medical or surgical treatment, and the most effective method of treatment available at present is the use of devices and techniques that compensate for hearing loss. The elderly, their families, and health care providers need information about the kinds of devices that are available to compensate for hearing impairment.

Assistive listening devices have been developed in the United States primarily by universities with rehabilitation programs and by commercial manufacturers. Marketing of new devices has been a problem, and testing procedures for devices have been inadequate. In some industrial countries such as Sweden, development, funding, dissemination, and repair of devices are considered a national responsibility. In the United States the Veterans Administration (VA) has a comprehensive program of device development, testing, and patient services, but outside of the VA, the delivery system is splintered and often ineffective. Extension of the VA model of services could stimulate device development and improved service delivery.

A final concern is the failure of the hearing impaired elderly to utilize aural rehabilitation services. Although hearing loss in the elderly is often mild or moderate, it is not simple, and its effects can be very serious. Government initiatives to increase the use of aural rehabilitation services could include increased funding and simplification of the complex requirements for these services under Medicare and Medicaid. In addition, public education programs are needed to increase awareness of the potential benefit of these services among the hearing impaired elderly and their families.

Osteoarthritis

Osteoarthritis is one of the most important causes of chronic disability in the United States and other developed countries. The disease is found in all organisms with bony skeletons[6] (98). Although it is not a disease of modernity—evidence of it has been found in the skeletons of Neanderthal Man and even some dinosaurs—because the incidence of osteoarthritis rises with age, and because its prevalence increases as individuals live longer, it has become much more common in recent years. This rising prevalence may give osteoarthritis the "highest morbidity rate of all mankind's diseases" (98). Some evidence of the disease has been found in 90 percent of people by age 40 (in autopsy studies), but it causes symptoms only in a minority at that age.

Variations in diagnostic criteria render statistics on incidence and prevalence uncertain, as they are for many other disorders. All estimates, however, indicate that the process that underlies osteoarthritis occurs in almost everyone if they live long enough, and that symptoms become increasingly prevalent and more intense with age. The disease is severe enough in 16 million to 20 million Americans to cause symptoms (97,105). Some form of arthritis other than rheumatoid arthritis was reported as affecting 47.5 percent of those over 65 in 1981 (see *Appendix A: Morbidity and Mortality Data*) and osteoarthritis would constitute the vast majority of such cases. Osteoarthritis causing severe or moderate pain was noted in 6.6 percent of those 65 to 74 in the National Health and Nutrition Examination Survey (this includes only those cases for which patients reported symptoms) (112). Had older age groups been surveyed, the prevalence would have been far higher. Other surveys have found evidence of the disease in patients to dramatically increase with age; changes in joint X-rays can be found in only 4 percent of those aged 18 to 24, but in 85 percent of those 75 to 79 (105). Of those showing some X-ray evidence of the disorder, 23 percent reported moderate or severe symptoms. The prevalence of osteoarthritis is higher in white populations and lower in blacks, American Indians, and Asians living in Asia.

Osteoarthritis is a major factor in health care costs and patient morbidity, but, like dementia, is not a direct cause of death. Osteoarthritis causes an estimated 46 million visits to physicians, 3.7 million hospital days, 185 days spent in bed away from the hospital, and loss of 68 million workdays per year in the United States (104). The Arthritis Foundation estimated the total costs of all forms of arthritis at $13.3 billion in 1983 (96), of which osteoarthritis accounted for approximately 60 to 70 percent (more than $7 billion). Although it is only one of hundreds of causes of arthritis, it affects far more individuals than any other cause.

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[6] Sharks, which do not have bony skeletons, but do have cartilaginous ones, are evidently immune to the ravages of osteoarthritis.

Osteoarthritis should not be confused with rheumatoid arthritis; only osteoarthritis is reviewed in this report. Rheumatoid arthritis is the second most common form of arthritis, affecting an estimated 6 million to 7 million people, but its prevalence in many younger age groups makes it less a disease of aging. Its cause is thought to be disrupted immune function, and is quite distinct from the process underlying osteoarthritis.

Definitions and prevalence

Arthritis means inflammation of the joint,[7] of which osteoarthritis is one cause. Other names for osteoarthritis include "degenerative joint disease," "osteoarthrosis,"[8] and "hypertrophic arthritis." These alternative labels reflect a degree of medical disagreement about the disease process, but the debate over proper terminology is not germane to public policy regarding the condition itself. OTA has selected "osteoarthritis" because it is the most common term. Osteoarthritis, as used here, refers to the combination of biochemical and anatomical changes in the joint that cause symptoms in at least one joint.

Medical definitions of the disease are subject to some controversy. Most physicians consider the diagnosis if there is pain or stiffness and X-ray evidence of joint damage. There is disagreement, however, about the X-ray changes that indicate osteoarthritis. Some physicians look for unusual bone formations (osteophytes) around the affected joint. Others do not make the diagnosis without evidence of joint narrowing and changes in the bone underlying affected joints.

What is osteoarthritis?

Osteoarthritis is the symptomatic disruption of joint function. Functional impairment arises from the biological changes described in this section, which provide an introduction to the biology and anatomy underlying osteoarthritis.

Joints are fluid-filled spaces lined by cartilage and separating bones; those found on the limbs (legs and arms) are adapted to permit easy movement. Limb joints are most affected by this disease, especially those responsible for weight-bearing (hips and knees), the vertebrae, and (for unknown reasons) the joints closest to the tips of the fingers.

Arm and leg joints are composed of a fluid-filled cavity, surrounded by a fibrous capsule (see fig. 15). The surfaces that move against one another are composed of cartilage. The cartilage sits over bone. The cartilaginous surfaces are extremely well adapted to ease of movement; they are four times as slippery as Teflon®, one of the most frictionless artificial surfaces (98). Disruption of the health of the cartilage tissue can reduce this ease of movement, leading to joint stiffness. Irritation of surrounding tissues leads to the symptom of pain. Osteoarthritis is one of the causes of ill health of the joint cartilage.

Many types of injury to cartilage can lead to changes similar to those seen in osteoarthritis (102). Such changes include degeneration of the cartilage, faulty attempts at repair, anatomic clefts and blisters, and even complete exposure of underlying bone. Injury can be caused by imposed immobility, removal of tissues that support the joint, and extreme compression. The similarity of normal cartilage repair to osteoarthritis has led some to hypothesize that the disease is an abnormal response to constant minor injury.

Joint cartilage relies on adjacent tissues for its health. The surface of joint cartilage is coated with special long chains of sugars and proteins. Biochemical changes of these coatings have been associated with damage to cartilage, and can reduce the slipperiness of the surfaces, causing increased friction and yet more tissue damage.

Because cartilage does not contain blood vessels,[9] it gets its nutrients and other factors from the surrounding soft tissues and, more importantly, underlying bone. Proper cartilage repair ap-

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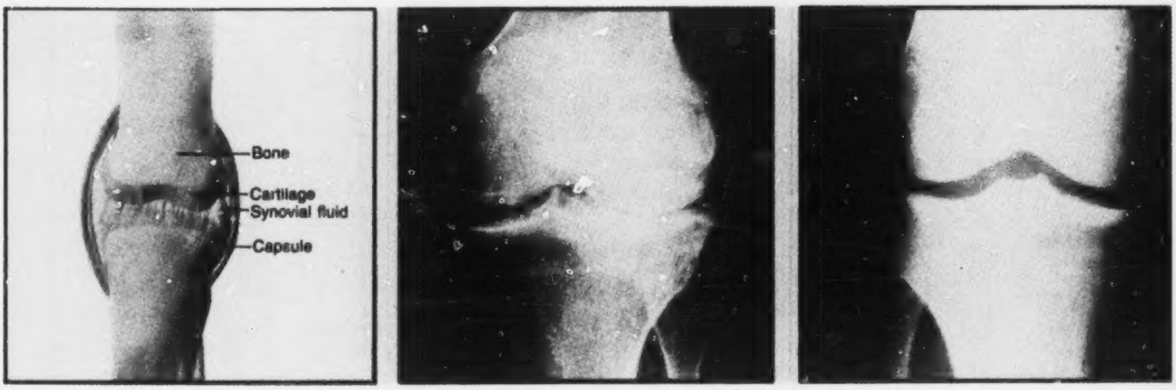
[7] From: arthro-(joint) + -itis (inflammation).

[8] From: osteo-(bone) + arthro-(joint) + -osis (process).

[9] Blood vessels appear to be prevented from growing into cartilage by a molecule that is produced by the cartilage.

Figure 15.—Diagram of Knee Joint



X-Ray Photograph of Arthritic Knee Joint

X-Ray Photograph of Normal Knee Joint

SOURCE: National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases.

pears to require access to cells in the bone marrow (102). The repair process may be sensitive to influences from other tissues as well, including hormones (thyroid-stimulating hormone and somatomedin have been postulated) and other chemical messengers (growth factors, growth suppressors, and certain nucleotides have all been suggested) (98,102). Osteoarthritis can, over a long period, lead to severe joint deformity, enlargement of surrounding tissues, and immobility.

Risk factors

The most important risk factor for arthritis is age, which cannot be controlled. Other uncontrollable factors include (105):

- body type (risk is increased in stocky individuals, decreased in tall thin people);
- race (risk is increased in Caucasians over blacks, Asians, and American Indians);
- diabetes (which may be partially controllable when due to obesity) (98); and
- genetic traits (one possible form is influenced by sex chromosomes; another involves many genes).

There are also some controllable risk factors:

- obesity (many studies support this, but some do not) (98);
- occupation (risk is increased in coal miners, dock workers, and dominant hands of weavers, but not in pneumatic hammer drillers); and
- exercise.

One possible risk factor, exercise, deserves special mention. Many orthopedic surgeons fear that the current popularity of jogging and other vigorous exercises may exacerbate osteoarthritis. It would be ironic if strategies that could prevent some deaths (e.g., from cardiovascular disease and stroke) were to worsen disability due to osteoarthritis. There is ample evidence that overexercise can worsen the condition of those who have the disease. Evidence that exercise can *precipitate* it, however, is unclear. Studies of marathon runners did not show more osteoarthritis of the hip, and studies of soccer players showed some indications of the disease, but other signs and symptoms were absent (105). Whether osteoarthritis can be caused by exercise thus remains an important unanswered question.

Diagnosis

The diagnosis of osteoarthritis is made by correlating symptoms of pain and stiffness with X-ray evidence of changes in joints. Other causes of arthritis must be eliminated by history, physical examination, and laboratory tests. Such other causes include infection, deposits of mineral crystals (from gout or other metabolic disorders), and some systemic diseases. One problem in making the diagnosis is that some patients wait for prolonged periods before seeing a professional. Another problem is that physician and patient perceptions of the severity of the illness may differ. One study found that while physicians' and patients' judgments of the degree of disability agree for low levels, physicians may underrate the disability at higher levels (where such error may make a greater difference) (107). The authors point out that this can erode mutual trust, and can lead to a paradox in that the physician believes that treatment is successful, but the patient does not.

Prevention of disability and treatment

The Arthritis Foundation notes that patients with osteoarthritis wait an average of 4 years before seeking medical attention from a physician. This is unfortunate, because the progression of the disease can be retarded, and its symptoms ameliorated by routine treatments (table 9).

CHANGING THE PATIENT'S ENVIRONMENT AND HABITS

Some symptoms of osteoarthritis can be prevented by treatment and directed programs of exercise and physical therapy. Some simple interventions can greatly retard the progression of the disease. Use of a cane can, for example, reduce the stress placed on the hip during walking by a factor of 2 or 3 (113). Changing the environment by adapting beds and chairs for easier entry and exit, and arranging living space to avoid use of stairs can greatly diminish the demands on the individual, and can minimize the need for movements that exacerbate the disease (113).

Weight reduction is often recommended to reduce the weight strain placed on knees and hips. Job changes away from physically demanding occupations may reduce joint wear and tear, and altering sports activities may be necessary to prevent acceleration of joint degeneration.

Devices that compensate for diminished function, especially of the hand and major joints of the legs, could greatly improve the independent and relatively normal functioning of those affected by osteoarthritis. There appears to have been little attention given, for example, to designing computer keyboards to make them accessible to the millions of Americans whose hand mobility is restricted by this disease.

Table 9.—Treatments for Arthritis

Assistive devices:
- Canes and devices that facilitate walking
- Special utensils
- Adapted furniture
- Special stairways
- Enlarged keyboards
- One-floor architecture

Physical therapy:
- Balanced program of rest and exercise
- Special movement and relaxation therapy directed at specific joints
- Weight loss

Drug therapy:
- Aspirin
- Nonsteroidal anti-inflammatory agents
- Others (steroids, etc.)

Surgical therapy:
- Hip joint replacement
- Bone reshaping (osteotomy)
- Joint debridement

Future possibilities:
- Specific hormones or growth factors active on joint cartilage
- Joint surface replacement
- Cartilage transplantation
- Improved joint replacement techniques and replacements for joints in addition to the hip
- More and better assistive devices

SOURCE: Office of Technology Assessment.

PHYSICAL THERAPY

Treatment of osteoarthritis involves balancing joint movement with protecting the joint from excessive movement. This implies the need for a proper balance between exercise and rest. Weight bearing and movement are imperative for proper cartilage repair (98), but overexercise is a well-known cause of excess disability. Physical therapists, physiatrists (physicians engaged in physical therapy), and other providers can be effective in reducing muscle spasm and in training patients to exercise and rest specific joints.

DRUG THERAPY

There are several drug therapies for osteoarthritis. The most common is the use of high doses of aspirin. Aspirin has the unusual characteristic of being both a painkiller and an anti-inflammatory agent, which makes it suitable for treating both the process that causes pain (inflammation), and the pain itself. Aspirin may also directly affect some biochemical processes involved in cartilage repair, thus improving the repair process. But because it can cause digestive disturbances, ringing in the ears, and other adverse effects, and some patients have violent reactions to it, aspirin cannot be used by all patients. Further, recent reports based on animal studies suggest that some effects of aspirin can inhibit proper healing of arthritic joints (101,108). Such studies have not yet been extended to research on humans, hence their relevance to standard therapy is not yet clear.

Among the other drugs used in treating osteoarthritis, the most common is a class of drugs called nonsteroidal anti-inflammatory drugs. These reduce joint inflammation and can prevent some of the resulting pain and stiffness. Many such agents are widely prescribed, including indomethacin (Indocin®), ibuprofen (Motrin®), naproxen (Naprosyn®), and others. These drugs are, in general, reserved for patients who cannot tolerate aspirin. They are more costly than aspirin, and have significant side effects (109). Several drugs in this group have recently been withdrawn from the market because of side effects, and two others are currently under investigation by FDA. Development of safer anti-arthritic drugs in this class is a high priority in the laboratories of many pharmaceutical manufacturers.

Steroid drugs are not generally used for routine treatment because of the many possible side effects, but they can be effectively used by local injection for flare-ups, or before surgery.

SURGERY

Total joint replacement is a relatively new technique, made possible by technological advances in low-friction materials, biocompatible plastics and metals, and development of cements that can function in bone. The joint most commonly replaced is the hip, but some centers are also performing knee replacement surgery, and surgery on other joints, such as fingers and shoulders, on an experimental basis.

More than 60 percent of the 75,000 total hip replacements done in the United States annually are done in those over 65, mainly because of osteoarthritis (110). Hip replacement is now a routine procedure, which can reduce pain, improve mobility, and has a low risk of failure. The risk of death during the operation is less than 1 percent, and the risk of infection is similarly low. Included in the 1-percent risk are clot formation in leg veins (clots can cause severe problems if they break off and pass through the heart to the lungs). Temporary urinary retention is found in 15 to 30 percent of patients. A major conference on the subject at the National Institutes of Health (NIH) concluded that hip replacement "when done for incapacitating pain and dysfunction . . . gives a predictably excellent result in the vast majority of patients" (110).

The same conference found that present technology results in 90 percent of devices remaining functional 10 years after surgery (110). The main complication of total hip replacement is loosening of the apparatus. Fracture of the device occurs in approximately 0.5 percent of cases. A search for improved cements to keep the devices in place, and development of devices that do not require cement (by allowing bone growth into the device) are underway (105). New technologies also may permit detection of loosening by detecting sounds of the device under stress (111). Surgical replacement of hips and other joints is effective, but expensive.

It is estimated that $700 million was spent in 1979 for hip replacements alone, 59 percent of which was done to replace joints affected by osteoarthritis (103). The rising numbers of elderly in the U.S. population, especially of those who are very old, suggests a rapid increase in this total unless means of preventing osteoarthritis can be found. The potential for cost growth as more joint replacements are done is a topic of concern for health policymakers. There are large numbers of potential recipients, and as the technology advances, such surgery may well become more attractive to a larger proportion of those with osteoarthritis or osteoporosis. This raises the prospect of difficulty in establishing criteria for deciding who should be entitled to joint replacement, establishing publicly acceptable mechanisms for rationing or otherwise constraining access to joint replacement through Federal programs, or continued cost escalation driven by demand.

Osteotomy involves reshaping the bone to reduce stress, or to provide a more favorable anatomic orientation of the joint. It is now less commonly used because of the advent of total joint replacements. *Joint debridement* is removal of unwanted tissue from the joint space, and can help when there is free cartilage or bone irritating the joint. *Hip surface replacement* is also being tried for some cases of arthritis, mainly in younger patients (106).

POSSIBLE FUTURE DEVELOPMENTS

Future prevention and therapy of osteoarthritis may include new drugs to promote cartilage growth and regeneration, production of growth factors and hormones through biotechnology, improved joint replacement, regrowth or replacement of joint surfaces, and development of devices to compensate for diminished function. Increased attention to this potentially large market by companies that produce devices could also greatly improve the functioning of arthritic individuals. Designers of chairs, stairways, beds, telephones, and computer keyboards are likely to adapt their designs for use by the growing numbers of those affected by arthritis. Development of "smart" technologies to assist in daily activities should prove highly marketable to this large subpopulation.

Quackery

A major problem in arthritis treatment is the proliferation of quack remedies and consumer fraud. The Consumers Union notes that "quackery thrives best on human illnesses for which there is no cure" (99). The persistent and unremitting symptoms of pain and stiffness also spur the search for remedy, or the promise of it. The large number of affected individuals encourages promoters to try to tap this potentially lucrative market. Both chronic discomfort and high prevalence contribute to the problem of quackery. Further, the episodic nature of the illness can breed personal anecdotes of "successful" treatments, when an individual happens to take action just at the time the symptoms are naturally subsiding.

One additional factor can render arthritis victims vulnerable to the attractions of useless substances, devices, and procedures: the patient's perception that traditional medicine has failed. This can be exacerbated by the frequent disparity between the patient's own measure of discomfort and that acknowledged by medical practitioners.

The Arthritis Foundation has variously estimated the amount spent on false or unproven remedies as $950,000 and $1.8 million (96,97). Quackery can take many forms:

- drugs;
- chemical mixtures (often containing hormones);
- diets;
- special "clinics";
- devices; and
- "therapeutic" jewelry (e.g., copper bracelets, gold, etc.).

Examples of useless or unproven remedies include DMSO, a common chemical solvent, which has been heavily promoted for relief of arthritic symptoms, despite a lack of verifiable effects. Copper bracelets were popular for a time, and one patently fraudulent device, the "Vryllium Tube," consisted of $0.02 worth of salt and sold for $250. Special clinics in Mexico and the Dominican Republic have catered to the desperation of arthritis victims, and special diets and diet books can be found in profusion (99).

The creative marketing techniques sometimes used by American drug companies, encourage unenlightened self-medication. Promoting agents to the public for relief of arthritis symptoms can lead to inaccurate self-diagnosis, and, in the words of a 1977 FDA panel, "Consumers who self-treat with an over-the-counter pain reliever for these diseases, without first seeking medical attention, may be risking irreversible damage to joints and other tissues" (99).

Social factors

As with any other chronic condition, optimal patient functioning relies not only on physiologic change and medical intervention but also on social variables and public policy:

It is clear that patient motivation, patient compliance, education level, socioeconomic status, arrangement of health care resources in the community, payment mechanisms, public and patient education programs, and family support, among other factors, may be as important determinants of disability as are the biologic activity of the disease or the extent to which that biologic activity may be controlled by medicinal agents (100).

Osteoporosis[10]

Introduction

Osteoporosis ("porous bone") is a major chronic disorder of older people. It is defined as a condition in which total bone mass is decreased while bone volume is unchanged; therefore the density of the bone decreases. This thinning of the bone increases its fragility and makes it more susceptible to fracture. Activities and stresses that would not harm normal bone can result in fractures of osteoporotic bone. Loss of bone mass occurs in all people as they age, but the rate of loss is higher in women for about 10 years immediately following menopause. This period of rapid loss causes women to be especially subject to fractures and the secondary problems that ensue.

This predisposition to fracture makes osteoporosis of significant importance to individuals over 40 and to the health care system.

Magnitude of the clinical and social problem

Osteoporosis is an important cause of morbidity and mortality in the elderly. It appears to be the underlying cause of about two-thirds of hip fractures in older people (132). The incidence of hip fractures due to osteoporosis was estimated to be 98 per 100,000 people in the United States in 1977 (130,132); their total annual cost (acute care only) was estimated to be about $800 million. The total cost of osteoporosis in the United States has been estimated at $3.8 billion annually, and osteoporosis affects 15 million to 20 million Americans (145).

Greater life expectancy and rising health care costs are expected to sharply increase the costs related to hip fractures. The total number of patient days spent in general hospitals as a result of hip fractures now ranks 10th among conditions counted (131). Fractures of the wrist are also a problem in people with osteoporosis and can result from relatively minor stresses. Vertebral fractures are common; it is estimated that 25 percent of white women have at least one vertebral fracture by the age of 60 (122). Most of these fractures are compression fractures—"crush fractures"—in which the vertebra simply collapses from the weight of maintaining the body in the upright position. Vertebral fractures often go unrecognized as fractures but may cause considerable pain. The pain frequently is not restricted to the area of the fracture, but can be felt in other areas, such as the abdomen.

The immediate medical and surgical problems posed by these fractures frequently foreshadow a significant impact on the individual's lifestyle. A number of studies of patients who suffered hip fractures (117,122,125,131) indicate a 16- to 40-percent increase in mortality within the first year. Only about 50 percent of patients are likely to return to pre-fracture mobility; approximately one-third enter nursing homes and remain there permanently (127,129,131). Mortality rates related to hip fractures were found to be higher in older patients (over 80), males, and patients with dementia or confusion (131). Of those patients who were living at home prior to the fracture and ultimately returned home, about 20 percent had to spend some time in a nursing facility during the interim (127,131). This nursing care tends to incur considerable expense, which is generally not fully reimbursed by public or private health insurance. The social problems are also significant because the patient is separated from his or her friends, family, and regular activities, which can cause depression and other psychological problems.

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[10] This section written by Sheila Taube, Ph.D., as part of the NIH Grants Associates Training Program.

Direct costs of osteoporosis include diagnostic tests, drugs, surgery, prosthetic devices, physical therapy, long-term care, and social rehabilitation. The indirect costs include productivity decreases from lost labor and its impact on the gross national product, although most osteoporotic patients are older women who are no longer in the work force.

Biology and physiology

Bone consists of a soft protein framework that is hardened by deposition of calcium salts. It is a dynamic tissue that is constantly being remodeled (reshaped and renewed) throughout a person's life. Bones provide the skeletal structure for the body and also serve as a repository of minerals such as calcium, magnesium, phosphorus, and sodium, which are required for a variety of the body's functions. This remodeling of bone is accomplished by simultaneous resorption (removal of structural components) and formation (redeposition). Any condition in which resorption exceeds formation results in decreased bone mass.

Resorption and formation are usually tightly coupled so as to maintain bone structure and function. This coupling appears to be a localized phenomenon; the cells responsible for the resorption and formation processes are active in the same bone surface at the same time. The resorbing cells are called osteoclasts, and the forming cells are called osteoblasts. The two cell types together are considered to be a "remodeling unit." Turnover of bone is high when there are many "remodeling units" present and low when there are few. The relative rates of activity of the two cell types determine whether there is net gain or loss of bone mass.

An individual's total bone mass generally reaches a maximum in the second to fourth decade of life and then begins to decline. The initial rate of decline is the same for both men and women, about 0.5 percent per year. When women enter menopause, however, the rate of bone loss increases to 1.0 to 1.5 percent per year for about 10 years and then begins to slow again to a rate similar to that in men (138,141). The rate of bone loss differs for different parts of the skeleton (138). Bones most affected include the metacarpals (the bones between the wrist and the fingers), the neck of the femur (that part of the thigh bone which forms the hip), and the vertebrae. Different bones lose mass in different ways; bones of the spine are more prone to losing their internal structure, while those in the limbs become thin near the edges.

The cause of age-related bone loss is not clear. It appears that the rate of resorption is increased, but it has been difficult to find a consistent cause underlying this increase. The metabolic interactions involved in bone turnover are complex, and normal function depends on a balance of calcium intake, absorption into the blood, deposition in bone, and excretion. These processes are controlled by hormones (particularly parathyroid and adrenocortical hormones) and by vitamin D and its derivatives. They are also affected by dietary components other than calcium, such as protein, phosphorus, fiber, and others.

Specific parameters that have been examined have not provided consistent correlations between metabolic changes and increased bone loss. There has been no direct evidence that increases in parathyroid hormone levels associated with age are any greater in osteoporotic patients (120). There appears to be no relationship between the degree of bone loss and the age of onset of menopause (128). There have been no consistent changes in adrenocortical function documented in osteoporotic individuals, although suggestions have been made that subtle changes in function of the pituitary, adrenal, or gonadal glands might play a role in osteoporosis (128). Osteoporotic patients generally have lower body weight and less muscle mass than nonosteoporotic controls, but the significance of this observation is unclear (118,128). It is possible that tall thin people can less afford to lose bone mass than stockier people.

Current research is directed toward a better understanding of the molecular aspects of bone remodeling. Growth factors have been identified that stimulate osteoblasts (the cells responsible for bone formation). Human skeletal growth factor, for example, may couple bone formation and resorption and may be involved in osteoporosis (144). Attempts are being made to define the cells and molecules that affect activity of both the osteoblasts and the osteoclasts (135). With this knowledge, it may then be possible to manipulate the system to maintain the balance of activity necessary to prevent bone loss. Much of the current molecular research is on bone cells in culture, a technique only recently perfected; it will take time to relate findings in these experimental situations to events actually occurring in the body.

Diagnosis

The diagnosis of osteoporosis can present major difficulties. The diagnosis is made by exclusion; the doctor must determine that the patient has no other causes of bone loss, such as underlying metabolic disorders, metastatic cancer, malnutrition, or drug-induced disorders. The condition is frequently undiagnosed until a fracture occurs. Vertebral fractures are often detected by accident when a patient has an X-ray taken for some unrelated problem. Once fractures have occurred, examination usually reveals considerable bone loss. To make the diagnosis of osteoporosis, the physician must first exclude other possible causes of bone loss; if any specific disorders affecting bone are found, appropriate treatment is initiated. If no underlying cause is found, the condition is considered to be osteoporosis.

In order to attempt to prevent fractures resulting from bone loss, it must be possible to detect this loss early and to measure the rate of loss. Standard radiographic procedures are not sensitive enough to detect the early stages of the disease because 30 to 40 percent of the bone must be lost before osteoporotic changes can be detected by these techniques. Nevertheless, films of the spine and hand can aid in the differential diagnosis of osteoporosis by identifying other diseases, and are sensitive enough to detect later stages of osteoporosis. The characteristic changes in vertebral osteoporosis that distinguish this disease from other bone diseases generally occur in the lower portion of the spinal column (below the sixth thoracic vertebra, at the midchest level). Changes seen higher in the spine are usually due to other causes, such as cancer, trauma, or infection. The particular vertebral shape changes are also characteristic of osteoporosis; for example, the vertebral bodies may become increasingly biconcave and wedge-shaped. Other shape changes indicate that other disorders may be present. Similarly, hand films can provide clues for differential diagnosis since changes seen can distinguish between osteoporosis and underlying hormonal imbalances (137).

X-ray measurements are only useful once changes have occurred; a procedure that could detect very early losses and identify individuals at risk would be of far greater value. More sensitive methods for measuring bone density are being developed. Photon absorptiometry is a sophisticated method that employs a highly focused beam of light at one frequency to examine the total mass of bone in the path of the light. This technique is only useful for examining peripheral bones (in the arms and legs) and is not yet available at all medical centers. Dual photon absorptiometry, a modification of this technique, can be used to examine the spinal column but its availability is even more limited. Quantitative computerized axial tomography (CAT) scanning of the spine can be used to make careful density measurements of spinal bones, but is expensive and not widely used. All of these techniques are being improved in terms of precision and reduction of X-ray dose, but usefulness for routine screening must still be assessed. As yet there are no reliable markers in blood or urine that can be used to quantitate bone loss; some blood tests indicate metabolic disorders, but these do not measure the condition of specific bones.

Treatment and prevention

The ability to measure bone loss prior to fracture is likely to have important implications for prevention and treatment. The pattern of bone loss may provide physicians with clues concerning other underlying disorders as well as with prognostic information.

Treatment of osteoporosis is complex primarily because it involves care of problems arising from the underlying bone loss, that is, fractures and their sequelae. As discussed earlier, hip fractures are a major occurrence; surgical repair of the fracture or replacement of the hip is required.

Surgical techniques and prosthetic devices have improved, and death rates now appear to correlate more with age and predisposing disease than with common complications of surgery such as infections and embolisms. Total hip replacement is sometimes required. Fractures and the necessary immobilization following surgery further complicate the osteoporosis because lack of exercise results in further bone resorption and predisposes the individual to formation of clots in blood vessels.

Vertebral compression fractures cause pain, postural changes, and increased strain on the muscles of the torso. Treatment for pain and postural problems can include bed rest, analgesics, and orthopedic braces of various sorts. Bed rest must be balanced with a need for exercise because of the complications of immobility mentioned above, but rest may be necessary to remove the stress on the spine. Painkillers must be used carefully as well, because of side effects such as constipation and disorientation. Orthopedic braces can be very uncomfortable, but they do relieve the pressure on the spine and permit somewhat more mobility. Younger patients tolerate the rigid supports better than older patients. There are exercises that can be performed safely to relieve pain, but these should include only extension exercises; flexion can cause more pain and may result in new fractures (140).

A major treatment issue concerns the measures that can or should be taken to prevent further fractures once it is clear that clinical osteoporosis is present. Most studies indicate that lost trabeculae of bone (the spiny meshwork inside the bone) cannot be replaced, but significant research is being performed to determine how to decrease the rate of bone resorption. As more information is gained concerning the normal metabolism of bone, attempts are being made to enhance bone formation or decrease resorption. These include use of mineral supplements, vitamin therapy, hormonal therapy, and exercise. Aside from wide acceptance of calcium supplements, few, if any, of the "treatments" are accepted universally as effective. This is because more definitive studies are required to prove cause-and-effect relationships, or efficacy of treatments (121).

A consensus conference at NIH addressed the question of defining optimum treatment of osteoporosis in April 1984, and concluded that carefully monitored estrogen therapy, calcium supplementation, vitamin D administration or exposure to sunlight, and exercise are all potentially effective methods of treatment (145).

Vitamin D increases both bone resorption and formation. Experience with this vitamin and its analogs (all involved in calcium and bone metabolism) is limited, and the studies are inconclusive. The best results have been obtained with an activated form of vitamin D, but levels must be monitored with care since too high a dose can increase bone resorption (150). In general, vitamin D should be used carefully because it is easy to attain toxic levels.

Sodium fluoride (NaF) has been shown to increase bone mass, but the bone has unusual crystal structure and decreased elasticity. In addition, joint pain and severe gastrointestinal problems occur in as many as 50 percent of patients (139). Calcium supplements given with NaF result in more normal bone structure, but there are still side effects in one-third to one-half of patients, and it is not certain that the increased bone mass is associated with fewer fractures. A large clinical trial of NaF treatment is currently underway under sponsorship of NIH.

Hormone treatments may also prove effective in treating osteoporosis. Preliminary studies using parathyroid hormone or its active fragment have not been encouraging; both resorption and deposition increased (136). Use of estrogen, a female sex hormone, has received a great deal of attention. Most researchers now agree that estrogen therapy for the first few years following menopause slows the rate of bone loss to that of men or premenopausal women. Why female sex hormones affect bone physiology is not clear. Nevertheless, empirical studies support a consensus that low doses of estrogen[11] are beneficial in terms of bone formation and resorption, and in preventing fractures of the hip, in the arm, and above the wrist. (124,133,149). When to terminate treatment has not been agreed upon, and the minimum effective dose is under investigation (123). Another controversy arises over the dangers of estrogen treatment—the increased risks of both blood clotting and cancer of the lining of the uterus (endometrial carcinoma). For women who have had hysterectomies, estrogen therapy appears to be relatively safe because the risk of endometrial carcinoma is removed. A newly uncovered aspect of estrogen therapy, however, is encouraging; the overall mortality of women dying from all causes is lower for those treated with estrogen than for those who are not (116). The questions about estrogen use as a routine measure in postmenopausal women cannot be answered without more long-term prospective studies. These studies are difficult to perform because women have to be followed over many years (perhaps as long as 20 or 30 years), and there are ethical questions as well. The relative risks and costs of osteoporosis and endometrial carcinoma have been compared (148), and it has been suggested that if osteoporosis is already present, the risks of further deterioration are greater than for endometrial carcinoma. Because the issue has not been resolved to everyone's satisfaction, estrogen therapy has not been recommended as a regimen and its use is being evaluated on a case-by-case basis. FDA has, however, approved estrogen for treatment of osteoporosis at the physician's discretion, and carefully monitored estrogen therapy was recommended for white women at the NIH Consensus Conference (145).

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[11] When given cyclically with progestins and periodic withdrawal of both hormones to allow bleeding, analogous to uses for contraception and menstrual regulation.

One recent finding may change treatments for osteoporosis. Thiazide diuretics, used in the treatment of heart failure and hypertensions, appear to be associated with reduced numbers of bone fractures among women taking them (147). Further investigation of this phenomenon may lead to a new strategy for treatment.

Calcium intake and absorption are widely accepted as important in preventing osteoporosis (134). Calcium alone is considered effective in slowing bone resorption, but the amount of calcium in the diet decreases as people grow older because of changes in the foods they eat (121). In addition, absorption from the gut appears to decrease. The cause of this decrease is not clear. Increasing the intake of calcium does appear to increase the total amounts of absorption, and calcium is not toxic in the amounts necessary to provide adequate absorption (143). However, there are some contraindications to calcium supplements: decreased blood flow through kidney (diminishing kidney filtration rate), or hyperparathyroidism, but these conditions can be assessed prior to prescribing supplements.

Proper calcium intake should be maintained as people age, and this may require supplementation of the normal diet. In order to achieve absorption of the recommended amount of calcium (800 to 1,000 mg per day), it is probably necessary to consume 1.5 to 2 times this amount (still within the safe limits). Active forms of vitamin D that enhance calcium absorption from the intestine are under investigation by the FDA, and may prove useful in preventing osteoporosis. Calcium may not be the only mineral involved in osteoporosis. Zinc deficiency has also recently been associated with osteoporosis, but its the link to the thinning of bone has not been established (115).

Another critical element in maintaining bone health is exercise, specifically weight-bearing exercise. Bone mass decreases when physical activity is reduced. Studies of immobilized subjects have indicated that loss of bone begins very soon after immobilization, and on full bed-rest the calcium loss is about 200 to 300 mg per day (about one-fourth to one-third of the Recommended Dietary Allowance) (119). Exercise has been shown to increase bone mass in normal individuals during recovery from immobilization (146) and in women after menopause (114,142). Once osteoporosis has been diagnosed, the exercise program should be carefully designed to avoid stress to fragile bones.

Although this discussion has concentrated on treatment efforts aimed at further reducing bone loss and fractures once osteoporosis has been diagnosed, some comments also apply to prevention of the disease. Studies to date suggest that bone mass must be built and maintained prior to the fifth decade of life and that the greater the bone mass at its peak, the more the individual can afford to lose before the bone becomes subject to fracture (121). Women especially should be sure to eat calcium-rich foods and to carefully assess their diets to assure proper calcium intake.[12] Nutrition is a complex science, and calcium absorption and excretion are affected by other components of the diet such as protein (high protein increases calcium excretion) and fiber (effects are not clearly understood yet) so that an individual's entire diet must be analyzed to assure proper nutrition. It is also important for women to maintain muscle and bone mass through regular exercise. The NIH Consensus Conference recommended that women take 1,000 to 1,500 mg calcium daily, starting well before menopause (145).

To determine the extent to which age-related bone loss can be retarded by calcium supplementation, studies must be performed over a period of time that is long enough to permit accurate rates of loss to be calculated. Studies are needed to assess calcium absorption under different conditions, i.e., high concentrations of calcium, effects of other nutrients, etc. Prospective longitudinal studies are required to establish a firm relationship between calcium nutrition in early life and development of peak bone mass as well as the relationship between peak bone mass and later susceptibility to fracture. The longitudinal studies necessary to prove cause and effect are almost impossible to carry out because of the long time span over which observations and measurements must be made. However, some of the necessary evaluations could be included in ongoing longitudinal studies such as the Baltimore Longitudinal Study on Aging. One longitudinal study, sponsored by NIH, started in 1967. Those in the study are just now entering the age of susceptibility to osteoporosis.

Because the various methods of preventing or treating osteoporosis have not been rigorously compared for relative efficacy (126), there is a clear need for randomized clinical trials.

Summary

Osteoporosis affects a significant number of elderly individuals. The morbidity and mortality associated with fractures are costly in terms of hospital care, long-term care, and rehabilitation, and the social costs to the individual and his or her family are substantial, although they cannot be precisely measured. Although research on bone physiology suggests the availability of preventive measures and treatments to those who are susceptible to osteoporosis, most prevention methods still require confirmation by research. Earlier diagnosis is considered important to a better prognosis, and such new technologies as photon absorptiometry make earlier diagnosis possible.

Policy for basic biomedical research

Provision of health care for the increased numbers of older individuals in American society will involve activity in many sectors: prevention of disease, promotion of health, good nutrition, delivery of health care, diagnosis and treatment of diseases, and research into all of these. This section focuses on that segment of the Federal Government's activity related to biomedical research.

In light of the aging of the American population, those diseases that are more common in the elderly will affect a higher proportion of the total population. Research on aging and diseases that affect older people will therefore become progressively more important, and funds expended in this area are likely to benefit more individuals. The Federal Government devotes 27 percent of its funds to services for older citizens and disburses $53.5 billion for Medicare and Medicaid, the two largest health care programs for older Americans (154). In the most recent inventory of Federal research specifically on aging (but not including all research on diseases common in older people), a task force found Federal spending for biomedical research on aging was $177 million in 1980[13] (163). The agency supporting the largest amount of research on aging was the National Institute on Aging (NIA), which spent $42.3 million, or 24 percent of the total. These figures do not, however, include all research on such disorders prevalent among the older population as stroke, atherosclerosis, or arthritis. In terms of other disorders, such as dementia, NIA has taken the lead. Research figures on the diseases for which most research is performed at institutes other than NIA would significantly expand the totals. Precise figures cannot be given because surveying research on diseases important to the elderly population would entail making difficult judgments about which diseases to include, and would necessitate another, much larger, inventory effort.

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[12] Good sources of calcium in food are dairy products, and vegetables such as parsley, soybeans, and spinach. For those who cannot tolerate milk easily, yogurt is an acceptable substitute. Calcium supplements are readily available as over-the-counter products.

It is clear, however, based on research expenditures compared to health care costs, cited in other sections of this chapter, that research on several chronic conditions of older Americans is relatively neglected. Federal research expenditures on Alzheimer disease, for example, total less than $40 million, compared to $8 billion to $10 billion Federal outlays for acute and long-term care, and roughly equal contributions from private sources.

While there is no complete accounting of the resources devoted to research on all diseases of importance to the older American population, it is possible to make rough estimates of the relative Federal costs of health care and biomedical research for the total population. In 1982, costs of health care were $322 billion nationwide, accounting for 10.5 percent of the gross national product. In this same year, estimated total Federal and non-Federal funding for health research and development was $9.2 billion, or 2.9 percent of total spending on health care. Appropriations for the National Institutes of Health (NIH) were $3.6 billion, or 1.1 percent of the total spending for health care nationwide. NIH sponsors the vast majority of federally sponsored biomedical research (comprising 37 percent of all health research, and 69 percent of Federal support for overall biomedical research). An approximate figure for relative Federal spending for health care v. biomedical research might thus be estimated by comparing NIH funding to spending for federally funded health care through the two largest programs, Medicare and Medicaid. In 1982, these two health programs disbursed $83 billion from Federal sources. The NIH budget would constitute 4.4 percent of this total (see fig. 16).

Federal funding for biomedical research has remained fairly constant in real dollars over the past decade, but has declined as a proportion of health care costs from 3.9 percent in 1972 to 2.9 percent in 1982. Funding for biomedical research has also failed to keep pace with overall trends in research and development: the proportion of dollars going to biomedical v. other types of research declined from 12.4 percent in 1972 to 11.7 percent in 1982. The proportion of funding for health research provided by the Federal Government declined from its 1977-79 peak of 41 percent of all health research support to 36 percent in 1982, and is now approximately the same as the Federal share a decade ago (when it was also 36 percent) (see fig. 17).

There is no method of determining an optimal level of Federal spending for biomedical research overall or even for a particular disease or class of diseases. There is no competitive market that can establish an equilibrium among spending for prevention, diagnosis, treatment, delivery, and research. In the absence of such a self-correcting mechanism, decisions about the relative levels of support are made administratively, based on a calculus of mixed economic, biological, ethical, medical, and political considerations.

Congressional role in supporting research on aging

The growth of biomedical research in the United States has depended on action by Congress to authorize and fund the Federal agencies responsible for performing and coordinating research, especially at NIH. The NIH budget has grown from $48,000 in 1933 to $55 million in 1953 to $4.3 billion in 1984. This growth has oc-

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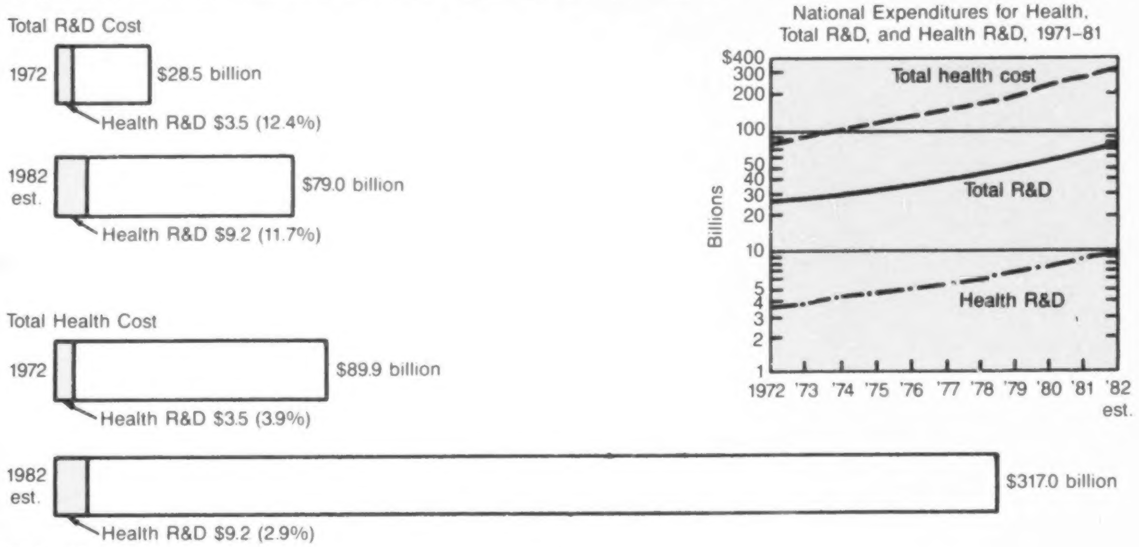
[13] This inventory was done primarily by computer search of abstracts for aging-related terms. This procedure would miss many basic science and clinical projects relevant to diseases highly prevalent in the older population that not did not include such terms.

Figure 16.—National Health R&D, 1972 and 1982, as Related to Total R&D Cost and Total Health Cost



SOURCE: NSF and NIH

SOURCE: HCFA, with adjustments of R&D (and therefore of totals) to conform to NIH data.

curred as a consequence of wide acceptance among congressional leaders of the importance of biomedical research. In 1974, Congress created a new institute at NIH, the National Institute on Aging, "for the conduct and support of biomedical, social, and behavioral research and training related to the aging process and the diseases and other special problems and needs of the aged" (Public Law 93-296).

NIA has taken a clear lead in research on some disorders. For example, it supports the largest effort on Alzheimer disease and dementia. NIA obligated $9.3 million out of a total of $22.3 million spent on Alzheimer disease in fiscal year 1983. This proportion will further expand with the substantial increase of funds designated for research on Alzheimer disease and related disorders in fiscal year 1984 ($36.4 million to $37.8 million). NIA was intended to focus its efforts on the disorders and problems of older Americans. NIA coordinates research among the various institutes, and incorporates biological and social science research into a national research plan on aging.

NIA has convened panels of experts to formulate planning for national research on aging. Their most recent report entitled, *A National Plan for Research on Aging* (165), has played a pivotal role in determining current research priorities.

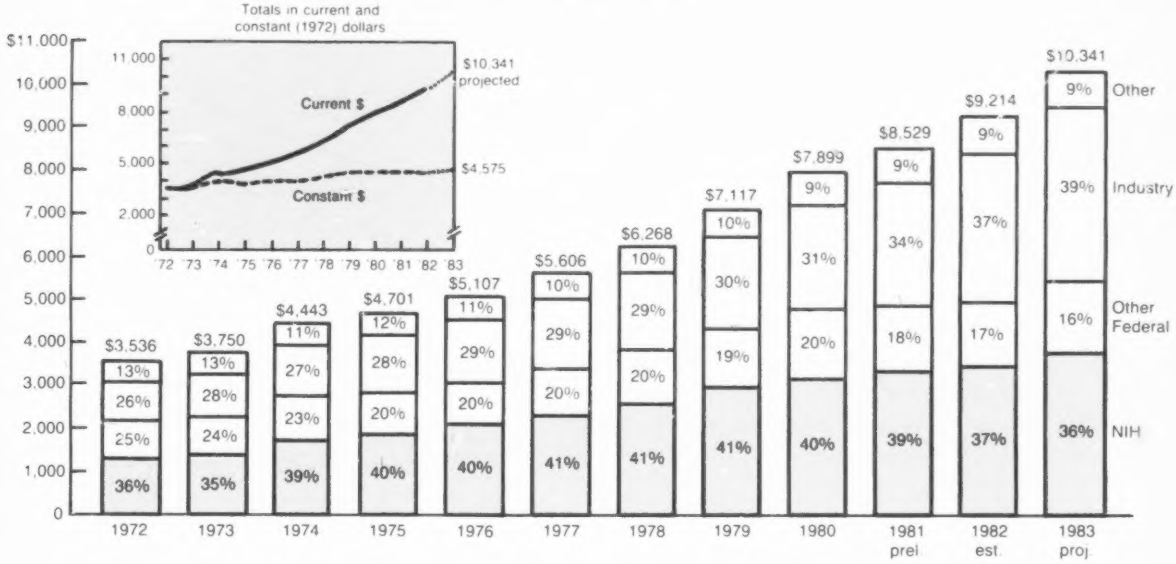
Congress has supported growth at NIA over the past decade. The appropriations figures itemized below show the rise in funding for NIA. Although these figures have not been adjusted for inflation, they do show an increase in the proportion of NIH funding devoted to aging research. But because NIA remains the second smallest of the institutes, the increase at NIA has little proportionate impact on overall NIH funding allocation. (For example, the 1983 appropriation of $91.6 million for NIA compares with $595.7 million for the National Heart, Lung, and Blood Institute (NHLBI) and $962.6 million for the National Cancer Institute.)

Appropriations for the National Institute on Aging (millions of dollars)

Fiscal year 1976	$ 19.3
Fiscal year 1977	30.0
Fiscal year 1978	37.3
Fiscal year 1979	56.9
Fiscal year 1980	70.0
Fiscal year 1981	75.6
Fiscal year 1982	81.9
Fiscal year 1983	91.6
Fiscal year 1984	112.3

SOURCE: Fiscal years 1976-82: NIH Data Book, NIH publication No. 83-1261; fiscal year 1983 and 1984: Congressional Record H 8445, Oct. 20, 1983.

Figure 17.—National Support for Health R&D by Source, 1972-83
(Dollars in Millions)



[a]Constant dollars based on biomedical R&D price index. 1972–1982. Projected to 226.0 for 1983. based on percentage increase in estimated GNP implicit price deflator

SOURCE: National Institutes of Health (164).

NHLBI provides most of the support for research on cardiovascular and respiratory diseases, disorders that are responsible for most deaths among older populations. The National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases (NIADDK) expends most of the funds that support work on arthritis and osteoporosis, conditions that are major causes of disability among the elderly. The National Cancer Institute funds research on cancer, one of the most feared killers of older Americans.

Reasons for supporting biomedical research on aging

HEALTH AS A JUSTIFICATION FOR BIOMEDICAL RESEARCH

The most compelling reason for supporting biomedical research is the future health of the American population. Investment in research now is a means of conferring improved health on present and future Americans, and providing information for use by all populations in the world.

The primary product of research is information that is freely available to all—that is exclusive to no particular group. This aspect of research places it in a category economists call "public goods." For example, a successful treatment of arthritis would improve society as a whole by decreasing demand for social services, and by improving the quality of life of countless individuals who cannot now be identified. Much as we all benefit from free access to information about weather, we are all better off for knowing how to prevent ill health. Most biomedical research is funded by the Federal Government because market mechanisms cannot serve to adequately allocate resources to long-term research. Market mechanisms fail, in part, because of both the high degree of uncertainty associated with basic research and the general applicability of many research results (a company does not gain relative advantage from investment if all companies can apply the results of its research). Progress in research is most rapid when there are many groups investigating closely related topics, and when research information is freely disseminated, another reason that private corporations cannot support research as easily as the public sector. An individual company's incentive to invest in research is reduced to the extent that it cannot control its use and dissemination: wide dissemination yields greater research efficiency overall, but provides less direct benefit to the sponsoring company. Further, no single company can support a research program large enough to assure a balanced program of research in large scientific areas. Since World War II, the Federal Government has adopted the responsibility for supporting basic biomedical research because of this absence of an adequate market mechanism.

The main justification for basic biomedical research is future reduction of mortality and morbidity. Reduced illness can reduce overall health care costs through:

- more effective prevention;
- reduction in the severity of disability leading to increased productivity;
- prolongation of productive life span;
- improved diagnosis allowing more specific treatment or prevention;
- reduction in the cost of a particular disorder (e.g., poliovirus vaccine reduced the need for supportive therapy of the victims of poliomyelitis);
- improved function in individuals permitting less use of medical care (e.g., treatment of cardiovascular illness permitting patients to remain at work, while also improving their quality of life);
- replacement of expensive treatment by a cheaper form (e.g., replacement of some surgery by new drugs for peptic ulcer disease, or replacement of coronary bypass surgery by drugs or catheter surgery);
- reduction in the number of useless therapies, incorrect diagnoses, or errors in treatment; and
- improved delivery of services.

Historical analysis suggests that each of these justifications for biomedical research can be supported in particular instances. Research can also, however, increase health care costs through:

- increased life span leading to a longer period of incurring health care costs for any particular condition;
- increased life span leading to acquisition of more disabilities;
- replacement of a lesser health cost with a greater health cost (e.g., those who would have died from polio have lived long enough to develop arthritis, coronary artery disease, and dementia[14]);
- discovery of new treatment modalities (e.g., new treatments for disorders that would previously have gone untreated, such as drug treatments for certain cancers);
- discovery of new methods of diagnosis (thereby incurring increased costs required to confirm or eliminate treatment alternatives);
- development of more complex therapy (e.g., multiple drug therapy for cancer in place of a single drug);
- requirement of testing for effective prevention (e.g., requiring a laboratory test for monitoring drug treatments);
- increasing medical errors by making diagnosis, treatment, or prevention more complex; or
- increasing the complexity of health care provision, thus requiring new capital outlays, new types of service providers, and more specialized education.

Basic biomedical research does not, therefore, necessarily lead to savings on health care costs in all cases. The goal of biomedical research is health, not parsimony. Federal investment in biomedical research can assure future generations of improved health, but reduction in the cost of health care is not guaranteed. Even improved health is not guaranteed, although it becomes increasingly probable as more resources are devoted to biomedical research.

ECONOMIC JUSTIFICATIONS FOR BIOMEDICAL RESEARCH

Future Savings in Health Care Costs.—While the most widely accepted reason to support biomedical research is the promise of better health in the future, there are also economic arguments for supporting basic biomedical research. In addition to the possible savings in health care costs for some technologies, several other economic results can follow from progress in biomedical research.

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[14] Prevention of polio, therefore, may actually increase lifetime health care costs for any particular individual. However, those who would have died of polio would also have been prevented from contributing to society. Premature mortality, conversely, may actually reduce health care costs but increase overall costs to society. Dead people cost less, but neither can they contribute.

Restoration of health can also permit a return to normal life, including contributing to economic or industrial productivity. Many studies of cost/benefit analysis relating to health take this factor into account. In the case of many older Americans, however, many of their activities are not included in standard economic calculations of productivity because they are retired. In such cases, cost/benefit analysis may underestimate the total benefits to society. Further, if the "human capital" approach of calculating lost wages were to be rigorously applied to health care resource allocation and research priority setting, resources would be preferentially assigned to younger working populations.

Industrial Applications.—One of the most exciting new developments in industry is biotechnology. The new biological technologies promise to become an important part of the international economy (161). The new industrial techniques comprising biotechnology all grew from biomedical research. Applications of biomedical research have thus spun off into the fields of environmental protection, food production, food processing, energy production, and even submarine detection. Such industrial changes constitute national returns on investment in biomedical research. These alone might provide sufficient justification for the investment, and at least provide additional reasons for funding basic research at the national level.

The health care industry is one of the largest in the United States, accounting for 10.5 percent of the gross national product. The health industry is highly labor-intensive, employing large numbers of service workers. Health care is one economic sector promising to produce many new jobs in the coming decades.

One important force driving the growth in health care is new biological and medical knowledge. New knowledge has led to new technologies for enhancing health and for industrial production. Examples of industries based, at least in part, on knowledge derived from biomedical research include pharmaceuticals, diagnostic device manufacture, hospital equipment production and distribution, and new biotechnology firms. Those employed include scientists, technicians, physicians, nurses, pharmacists, educators, social workers, administrators, and government regulators.

REASONS FOR SUPPORTING RESEARCH SPECIFICALLY ON AGING

NIA was created in response to a need perceived by Congress to focus research specifically on aging. This perception arose from the demographic pressures of anticipated growth in the older American population, the potential increase in health costs due to increasing numbers of chronically ill persons in this population, and neglect of research on aging (Public Law 93-296). Several functions distinguish research on aging from other biomedical and social science research.

Older individuals have biological characteristics that differ from younger cohorts. Examples cited in this report include their special susceptibility to side effects of drugs, increased incidence of particular disorders, and vulnerability to concurrent diseases and multiple organ failure. Older people are also more likely to suffer functional impairments for those conditions that they have, and are thus more vulnerable to limitations on their independence. The reasons underlying the reduction in functional reserve[15] that occurs in many organs are not known, and the fundamental processes that cause the phenomenon of aging are not understood. The primary goal of research on aging is resolution of these problems.

Resource allocation: who decides what

Congress determines funding levels for NIH and other research agencies through its budget process. As part of this process, decisions must be made about:

- how much research money is devoted to research overall;

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[15] Functional reserve is the ability of a tissue or organ to respond to new stresses without affecting the individual. A good example is the heart's response to vigorous exercise that diminishes with age.

- how many resources are given to biomedical v. other varieties of research;
- allocation among the various institutes;
- division within the institutes into intramural or extramural research (that done at NIH or elsewhere);
- division into basic research and clinical research;
- duration of support for each grant;
- division within the institutes into programs for disease groups or scientific areas; and
- allocation among research projects, training, investigator grants, institutional grants, clinical projects, technology transfer, development of applications, public information dissemination, and special activities.

Congressional debate about proper mechanisms for funding of biomedical research has intensified in recent years. Concerns have been expressed about how to properly allocate funds, how to organize research, and how to determine how much research should be in basic science and how much devoted to other activities (e.g., promoting development of new treatments, supporting clinical trials of new drugs or treatments, or disseminating information about health).

CRITERIA FOR ALLOCATION DECISIONS

There are at least four important determinants of successful biomedical research. Each of these is advocated by different groups in support of funding for a particular area of science or focused on a particular disease or group of disorders.

Scientific opportunity is important in productivity of any research. One cannot successfully study even the most important health problems if there are no scientific techniques with which to address the relevant questions. The study of bone diseases, for example, was inhibited until recently by the absence of tissue culture methods for studying bone and cartilage cells. Study of Alzheimer disease is still hampered by absence of an adequate animal disease model. In some instances, such scientific roadblocks can be creatively circumvented; in other cases, the barriers resist scientific inquiry. Scientists can, for example, develop new instruments or tests that permit information-gathering directly from affected patients (e.g., noninvasive new technologies for visualizing the living human brain), but cannot deliberately cause Alzheimer disease in animals or laboratory cells in order to study it.

The process of peer review by scientists has arisen to measure the scientific validity of individual grants or programs, thus promoting efficiency in research. Peer review is by no means flawless; studies have shown that there may be a substantial factor of luck and reviewer bias in some methods of peer review (162). Eliminating the peer review process would, however, sacrifice evaluation of factors that are *not* attributable to luck. Peer review might be improved, but is unlikely to be replaced, because there appears to be no other effective means of identifying scientific priorities.

Personnel and environment are also essential. Those doing the research must be properly trained, have access to necessary equipment, and have an environment of support from peers. In several areas there is a shortage of personnel trained to do research on a particular topic, which makes research less robust than it could be. Few medical researchers are trained to do computer research, for example, and still fewer Federal sources of fellowship provide support for training them. Many of the arguments in favor of functional assessment and prevention initiatives, cited in chapters 4 and 7, presuppose training and support of new researchers in these areas.

The environment for doing the research must provide needed support services and an intellectual atmosphere conducive to productive enquiry. Evaluation of both the adequacy of institutional support and aptitude of the individual researchers is another aspect of peer review.

One important reason for sponsoring intramural research at NIH and for the support of "centers of excellence" is the enhanced productivity achieved by concentrating groups of researchers close to one another. For example, it is not uncommon at many major research universities to find ready exchange of ideas at seminars, lectures, and through informal laboratory interchanges. This rapid and easy diffusion of ideas causes spread of new techniques into diverse fields, proliferation of approaches to scientific questions, and intensification and broadening of research training. There is thus a "critical mass" phenomenon associated with biomedical research: it is most productive where there is a sufficient number of highly qualified scientists available to exchange ideas. Not all research, however, is conducted at major research universities. Some scientists are more productive when left on their own, and many important ideas arise from those who take a completely fresh approach to a scientific problem, without being restrained by the ideas of those around them. There are different research styles, just as there are different styles of management.

Importance of solving a problem is a factor in allocating resources for research. Those problems that cause the most social disruption, the greatest number of deaths, or the highest levels of disability are those that society most wishes to solve. The "burden of illness" can be measured by numbers of people affected, severity of disability, public fear of developing a disorder, and untoward social and health effects associated with a given disorder. For example, cardiovascular diseases are the most frequent causes of mortality among the elderly; the severe symptoms of stroke and dementia cause distress for the patient and his or her family; arthritis causes chronic pain for a vast number of individuals, but kills few; and the prospect of cancer provokes widespread fear. Each of these aspects of disease bears on the political and administrative calculus of deciding how to distribute research dollars. Recent congressional debate has focused on how best to organize distribution of funds to NIH. Some prefer distributing funds along scientific lines (for research in neurobiology, metabolism, genetics, or for basic cell biology), while others favor increasing the focus on particular diseases or disease groups.

Duration of grant support: the length of time a research project is supported affects how science is performed. Shorter periods of grant support permit greater flexibility of resource allocation at the national level because long-term grants obligate funds in future years that cannot be redirected to new projects. Shorter grants also, however, require scientists to apply for funds more often, thus detracting from their primary function of investigation. Short-term grants also increase the paperwork associated with research support because of the necessity of filing more grant applications during the same period than would be needed for long-term commitments. Long-term grants also permit more stable assurance for research personnel and stable development of coordinated research programs. Decisions about grant duration at the national level thus balance the advantages of flexible yearly research priority assessment against the need to provide stable and reliable support for scientific investigation.

SPECIFIC CONGRESSIONAL INVOLVEMENT IN BIOMEDICAL RESEARCH

Congress creates new research institutions, annually authorizes and appropriates funding for research, and has control over some aspects of how funding is allocated. Congress makes decisions about resource allocation at three levels:

- Congress determines how much total funding to set aside for all biomedical research at the Federal level.
- Congress may also choose to play a role in allocating funds among the various institutes.[16]
- Congress may also ensure execution of particular projects or research plans.

The level of congressional involvement varies from allocating money to be used at the discretion of the Secretary of Health and Human Services (usually delegated to the Director of NIH) to specific funding for particular types of grants. Specific congressional involvement differs among disease groups, scientific areas, and executive institutions that support research. There have been historical variations in the intensity and specificity of congressional action. Examples of general actions include creation of the NIH and the larger institutes. Less general was the creation of NIA, which was intended to encourage research in an area of perceived neglect. Specific actions are common in support of particular diseases or disease groups. For example, there were several proposals for research specifically on Alzheimer disease in the most recent session of Congress. Decisions about congressional involvement in determining research priorities involves debate about the criteria named earlier: scientific opportunity, personnel, and social importance. It also involves judgments about the administrative costs of particular actions, and who is best able to decide questions of a particular type. In general, Congress is best at ascertaining the social and personal costs of a particular problem, while scientists, through the peer review process, are expert in assessing scientific validity. Congress can direct resources to important problems, and scientists can emphasize the importance of using the tools available.

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[16] Congress must specifically authorize and fund the National Cancer Institute and the National Heart, Lung, and Blood Institute because of the character of the legislation that created these two largest institutes at NIH. Other institutes are authorized under an "umbrella" authorization that provides spending authority if authorization has not passed Congress.

Judgments about proper allocation of resource funding are thus political in that they can involve resolution of sometimes conflicting contentions. There may often be no one right answer. When there is only one right answer, it may not be possible to identify it. The present system of allocating research funds incorporates the tension between the expertise of scientists, who assess scientific opportunity and research priority in a given area, and Congress, which establishes overall funding and general research priorities.

EXAMPLE OF CONGRESSIONAL POLICY DEBATE: A PROPOSED ARTHRITIS INSTITUTE

A prominent example of congressional debate about research policy surrounds creation of a new institute for the study of arthritis and musculoskeletal disorders, which was under consideration as this report was written (151,152, 158,160).

Those opposed to creation of a new institute cite increased administrative costs that would detract from money available for basic research (such costs are estimated by the Office of the Director of NIH at $4 million) (156) and express concern that proliferation of the number of institutes at NIH will make the organization difficult to manage. Those in favor of creating a new institute assert that research on arthritis is relatively neglected, and the presence of a new institute would focus scientific attention on this severe medical and social problem and facilitate efforts to garner support for arthritis research in Congress (thus increasing total funding for research, rather than merely reallocating funds from other areas) (159).

Proponents of the arthritis institute point out that spending is 22 times higher per affected patient for cancer research and 12 times higher for heart research than for arthritis research (153). By these same criteria, however, mental illness could be considered even more underfunded than arthritis, yet the presence of a National Institute of Mental Health (NIMH) has not remedied this. Some believe, in this context, that funding for NIMH would have been greater if NIMH had not been separated from NIH in the late 1960s (155). Differences here center on whether creating an institute at NIH in fact attracts increased resources for the topics investigated at that institute. The historical analysis in the upcoming Institute of Medicine study of the NIH (see below) may provide information that can contribute to resolving this issue.

Within the field of arthritis research, there is debate about the current distribution of funding. Some aver that funding is now too focused on immunology and away from basic cartilage and bone research. They advocate increasing research on the major causes of disability of osteoporosis and osteoarthritis with less emphasis on rheumatic arthritis and immunological disorders. Others counter that scientific opportunities in bone and cartilage research are restrained by the absence of adequate scientific methods and shortage of trained researchers in this area. They point out that research on immunological mechanisms has been extremely productive, and should continue to be so. Those favoring research on osteoarthritis counter that the productivity of immunological research is due to availability of Federal funding for it, and that bone and cartilage research would have been equally productive if it had been as well supported over the last decade.

Such debates highlight the difficulties of allocating funding in the absence of a natural market. Targeting of research on particular diseases emphasizes the importance of the problems to be addressed, while targeting on particular methods of scientific approach or organ system stresses scientific opportunity. In most cases, these values do not conflict, but when they do, there are usually good arguments on both sides of the debate.

Congress is then forced to make an administrative decision fraught with a high degree of uncertainty. High levels of spending for heart and cancer research arose from congressional action and concerted public efforts persistently pursued since the 1950s. The present high level of scientific achievement in these fields and the industrial spinoffs (biotechnology and medical technology) of such research are the beneficial effects of more than two decades of committed Federal support. Whether creation of an institute for the study of arthritis and musculoskeletal disorders will achieve its goals of scientific excellence and amelioration of disability may depend as much on the consistency of support from Congress over the next decade as on the establishment of a new institutional home for musculoskeletal research.

The status of a new institute for the study of arthritis, musculoskeletal, and skin diseases is uncertain as this assessment is written. The Senate and House of Representatives of the 98th Congress passed S. 540 authorizing the creation of such an institute, but the bill was vetoed by President Reagan on October 30, 1984.

ANOTHER EXAMPLE: PROGRAMS FOR PREVENTION RESEARCH AND EDUCATION

Concern that research on disease prevention and health promotion has been relatively neglected prompted Congress to mandate Associate Directors for Prevention Research at the National Cancer Institute, National Institute on Child Health and Human Development, and the Office of the NIH Director, in addition to the one already in place at the National Heart, Lung, and Blood Institute. The function of these new offices would have been to assure that research on prevention, health-promoting behavior, epidemiology, and disease causation was given high priority at the respective institutes.

In addition, passage of S. 771 authorized a revision and extension of the Office of Health Promotion and Disease Prevention of the Public Health Service. The bill included provisions to create a network of centers for health promotion and disease prevention. The centers were to perform basic applied research in preventive health. The bill contained authorization sufficient to support 13 center grants in fiscal years 1985, 1986, and 1987. The arguments for this new legislation in the structure of NIH were similar in type, although different in detail from those urging establishment of the arthritis institute. These other health research bills were also vetoed on October 30, 1984.

ORGANIZATION OF THE NATIONAL INSTITUTES OF HEALTH: IOM STUDY

The proposed institute on arthritis is only one of many changes in NIH debated over the past decade. As a result of this debate, the organization of the National Institutes of Health is being studied by the Institute of Medicine (IOM). The results of this study, *The Organizational Structure of the National Institutes of Health,* was released on November 15, 1984. The study focused on criteria for creation of institutes, how to support solid basic science, and how to best respond to medical needs and social burdens (157).

The study has three components:

- a historical review of how institutes were formed, how association with or dissociation from NIH has affected different institutes, and how institutes have split or had new functions added to existing institutes;
- a survey of the current organization of NIH, including how priorities are set and a review of potential additions to NIH, and review of proposed alternative organizational structures; and
- an analysis of alternative means of organizing NIH, including criteria for goal setting, decisionmaking, priority setting, and budget authority.

Conclusion

The prevalence of major chronic diseases is expected to rise over the next decade. If current trends continue, dementia, hearing impairments, urinary incontinence, osteoporosis, and osteoarthritis will continue to increase in incidence and prevalence as the population ages and as the average age at death continues to rise. Effective treatment for prevention of these disorders is needed, and adaptation of technology to compensate for the ravages of chronic disabilities will be more and more in demand in the future. For conditions that may be ameliorated by existing technologies, such as hearing impairment and incontinence, application of such technologies is a priority. Research on chronic diseases, however, provides the only possibility for ultimately eliminating them.

Congressional issues and options regarding basic biomedical research

Support for basic biomedical research is growing rapidly. It has resulted in the creation and growing budget of the National Institute on Aging and support of research in other NIH institutes and Federal agencies on diseases prevalent among the older population. Such research has not, however, attained the status or level of support enjoyed by other groups of disorders, such as cancer or heart disease. Increasing efforts by private citizen organizations such as the Alzheimer Disease and Related Disorders Association and the Arthritis Foundation have begun to change this, encouraging Federal policymakers to invest more research dollars in studying the diseases that cause severe disability among older Americans. Such increases in funding can be achieved by diverting funds from other areas of basic biomedical research, by increasing total funding for biomedical research, or by a combination of these strategies.

Issue 1: Should Congress increase support for basic and clinical biomedical research on aging?

Options:

1.1: Congress could continue present levels of support for aging research.

1.2: Congress could increase support for basic biomedical research on aging by devoting a larger share of the NIH budget to it.

1.3: Congress could increase support for basic biomedical research on aging by devoting more overall Federal funds to it.

Some believe that present levels of funding for aging research are adequate, and that devoting increased funds to this area could detract from research now going on in other areas. Others believe that the growing proportion of the older segment of the American population will necessitate a commensurate increase in knowledge about the biology of aging and about conditions highly prevalent in older Americans.

If Congress chooses to support more research on aging, it can take one of three general courses: either increase the overall NIH budget, earmarking more funding for aging, increase the proportion of the NIH budget devoted to aging research, or a combination (the combination would conform to recent trends).

Issue 2: Should Congress exercise more control over the direction of basic biomedical research?

Options:

2.1: Congress could delegate major decisions regarding biomedical research to the Director of NIH, the Public Health Service, and the Department of Health and Human Services.

2.2: Congress could increase its level of involvement in selected areas, such as general aging research, *creation of new institutes, and mandating new programs.*

2.3: *Congress could increase its level of involvement by changing the methods of authorizing and appropriating funds for NIH.*

Examples of option 2.2 would include the proposed new institute on arthritis and musculoskeletal disorders, new centers of excellence for Alzheimer disease, earmarking of funds for particular types of disease-oriented research, and mandating programs for disease prevention and health promotion. Examples of 2.3, involving regular reauthorization and appropriation of each institute and increased oversight of institute programs, were at the heart of debate about the original version of H.R. 2350 in 1983, before a compromise was reached with competing bills. The basic arguments were those noted above in the discussion about the specificity of congressional involvement in basic research policy and in the discussion about the proposed arthritis institute.

Increased congressional involvement in research policy would tend to favor more sensitivity to the needs of disease-oriented interest groups, which may represent the needs of their constituents; leaving administrative decisions to the present NIH hierarchy favors attention to scientific opportunity as assessed by peer review.

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Dementia

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Chapter 4

Health Promotion/Disease Prevention and Nutrition in the Elderly

Contents

Page

Introduction 119

Types of Prevention 120

Definitions and Wellness and Functional Dependence 120

Morbidity and Mortality 121

Risk Factors 121

  Risk Factors Associated With Coronary Heart Disease and Stroke 122

  Risk Factors Associated With Cancer 125

  Risk Factors Associated With Fractures 126

  Risk Factors Associated With Sensory Loss 127

  Risk Factors Associated With Dental Disease 128

Nutritional Deficiencies 128

Conclusions 129

Congressional Issues and Options 130

Technical Memorandum 133

Chapter 4 References 133

Chapter 4

Health Promotion/Disease Prevention and Nutrition in the Elderly

Introduction

People are living longer, and an increasing body of evidence is demonstrating that preventive measures begun early in life and maintained throughout life can significantly reduce the prevalence of acute and/or chronic diseases in old age. These measures include diet modification, regular exercise, smoking avoidance, and periodic medical screening, especially for blood pressure and cancer. At the same time, because of increases in life expectancy during the last 50 years, a generation of persons is growing up with the knowledge that if they practice healthy life behaviors, they are likely to live 70 or more years. Efforts to extend knowledge of behaviors that promote health and prevent crippling and chronic disease at older ages are thus becoming more important. Behavior alone cannot ensure longevity; however, the social and economic context is extremely important. People who cannot afford nourishing food, adequate housing, and essential medical care cannot live healthy lifestyles even if they know how to do so.

Because the focus of this study is the elderly, this chapter primarily treats preventive measures for persons 65 or more years of age. This is done, however, in full recognition of the importance of prevention throughout life.

Until recently there was consensus among health professionals, and among the elderly themselves, that after 65 it was too late to think seriously about prevention of disease or disability. For example, a 65-year-old would already have sustained too much lung damage through excessive smoking to justify quitting, or atherosclerosis would have progressed too far to make it worthwhile to undertake exercise and dietary modifications that might reverse the condition. These attitudes are slowly changing, and health promotion is now justified for several reasons:

- increasing life expectancy after 65 (half of those who reach 65 will live to be at least 80);
- more sophisticated definitions of health that recognize variability among and between age groups;
- better understanding of the importance of chronic disease and disability as major threats to health in the elderly and of the relationships between chronic disease and preventable risks;
- the recent improvement in cardiovascular disease mortality due in part to preventive efforts (e.g., control of hypertension);
- the desire of many older people to continue working (73 percent of persons over 65 would prefer to continue some kind of part-time work if they could (this percentage drops significantly for full-time work and for persons over 75) (26); and
- growing uncertainty about Social Security and pension plans that reinforces the desire to stay healthy and continue to work.

In implementing health promotion strategies, both the efficacy and goals of the intervention and the time in the life cycle are important. The efficacy of prevention is often difficult to demonstrate because of the problem of measuring the nonoccurrence of events (19). Preventive steps should be taken early in life in order to show effect in old age; this long time lag makes proving causality difficult. Also, many efficacious programs can increase functional independence or decrease chronic disease incidence; these parameters are more difficult to measure than death rate changes. For people who are ill, the goal of health promotion/disease prevention is to maximize function and prevent deterioration, while for those who are well the goal is the prevention of disease or disability irrespective of age. The goals of risk prevention are quite different for a 50-year-old than they are for an 80-year-old, and are further complicated by the overall health of the individual. At any age, however, the goal is to promote the maximum functional independence of which the individual is capable.

Types of prevention

Prevention is usually divided into three components: primary, secondary, and tertiary. Primary prevention refers to preventing the occurrence of disease or injury. Secondary prevention refers to early detection and intervention, preferably before the condition is clinically apparent. The aim of secondary prevention is to reverse, halt, or at least retard the worsening of a condition. Tertiary prevention refers to minimizing the effects of existing disease and disability by surveillance and maintenance designed to prevent complications and premature deterioration (21).

This traditional taxonomy is difficult to apply to specific cases and fits poorly into the chronic disease situations that characterize the elderly. A condition may be both a preventable disease (a problem on its own) and a precursor (risk factor) to a subsequent condition. For example, falls are not only common in older age groups but also constitute a risk factor for hip fracture. Hypertension is a medical condition that should be treated because it is a risk factor for stroke, heart disease, and kidney disease. When primary prevention of hypertension (e.g., control through diet modification) succeeds, it becomes tertiary prevention; control of hypertension is, in turn, a primary prevention strategy for stroke and arteriosclerosis (19). Control of diet (weight) is primary prevention for diabetes, which is, in turn, a risk factor for arteriosclerosis and stroke. And reducing arteriosclerosis can lower the incidence of stroke. Thus a particular risk factor can be a primary, secondary, or tertiary risk factor, depending on the disease.

Definitions of wellness and functional dependence

Of Americans 65 and over, more than half (56 percent) perceive their health to be excellent or good (26). More than 60 percent of adults 18 to 64 and more than 70 percent of those over 65 believe that health status has improved for older Americans. (This improvement may be associated with the evidence of increases in life expectancy. See *Appendix A: Morbidity and Mortality*.) Despite disagreement as to the validity of these self-ratings, there is evidence that they are useful measures of health status. Objective definitions of wellness or health are, however, difficult to develop.

The World Health Organization defines health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity."

Providers and scientists interested in health promotion/disease prevention have found this definition difficult to follow in practice. The linkage of functional dependence with health promotion provides a more fruitful approach. Functional dependence is defined as the inability to attend to one's own needs, which generally include the basic activities of daily living: walking, eating, personal hygiene, shopping, dressing, laundry, meal preparation, paying bills, and recreational and social activities. Dependence may result from changes that accompany natural aging, but is more likely a correlate of disease or a related pathological condition. Dependence can often be prevented, reversed, or reduced (14).

Several measures for assessing the degree of functional independence of the elderly have been developed. The Older Americans Resources and Services (OARS) assessment battery yields information on five functional activity areas. Another approach uses both clinical and epidemiologic criteria to specify health goals and professional services appropriate for 10 different age groups from birth to 75 years and over. A third method stresses functional independence defined from activities of daily living scales. These assessment measures are discussed further in chapters 7 and 9 and in the *Technical Memorandum* at the end of this chapter.

Morbidity and mortality

Today's leading causes of death—both in the general population and among those over 65—are diseases of the heart, malignant neoplasms (cancer), and cerebrovascular disease (stroke). As noted in chapter 2, these three conditions accounted for three out of every four deaths among the elderly in 1981. Death rates for stroke among the elderly decreased more rapidly during the past 30 years than those for heart disease, especially since the early 1970s, when stroke mortality fell sharply. Death rates for heart disease, which are also falling, showed a rapid decline between 1968 and 1978. In contrast, death rates for some cancers are rising, especially for cancer of the respiratory tract, and in men, genital and colon cancer. Overall cancer mortality among elderly women actually fell slightly between 1950 and 1978, but the incidence of lung cancer in women is rising.

The incidence of other leading causes of death such as pneumonia, influenza, arteriosclerosis, hypertension, and diabetes mellitus has fallen in recent years. Although the incidence of many of these killers has decreased, their prevalence has risen because the elderly are now more likely to survive stroke and coronary heart disease. The level of chronic disease in the elderly population is therefore rising. Because this burden of morbidity in the population is growing, it is important to examine the risk factors that are correlated with these diseases and chronic conditions.

Risk factors

A risk factor is a characteristic that can identify an individual as having an increased likelihood of developing a given condition. Risk factors are based on statistical probabilities in populations rather than on causal relationships or the certainty that an individual will develop a specific disease or condition. Nevertheless, knowing the risks associated with particular diseases can provide an opportunity for disease prevention or reduction.

Appropriate interventions are not possible without knowledge of risks. Some risk factors can be modified, while others are intrinsic to an individual. For example, personal habits and body weight can be changed, but age and genetic characteristics cannot. In certain circumstances, the effects of changeable characteristics become irreversible. Excess weight, for example, may be changeable at any age, yet the effects of obesity on risk of heart disease may be unchangeable at a given point. Unfortunately, the relationship between risk and specific interventions to reduce risk has not yet been well researched in the elderly, but enough is known about the effectiveness of certain prevention strategies to argue for their implementation.

The choice of which risk factors to modify should, in part, be made on philosophical and ethical bases. Because the cost of morbidity (especially chronic disease in the elderly), both in human suffering and economic terms, is an area of growing concern, another approach to health promotion is to assess which risks, if reduced, are most likely to significantly reduce human suffering and medical costs.

Risk factors associated with coronary heart disease and stroke

A number of risk factors correlate with both coronary heart disease (CHD) and stroke. One group, underlying physical conditions, includes hypertension, high levels of cholesterol, and impaired glucose tolerance. Another type, behavioral risk factors, includes smoking, lack of exercise, poor diet, and stress. Despite the lack of a direct cause-and-effect relationship between risk factors and CHD or stroke, it is clear that the risk of a coronary event increases exponentially as the number of risk factors increases (37).

HYPERTENSION

High blood pressure is the most powerful predictor of risk for CHD; more than half of persons with myocardial infarction and three-fourths of persons with stroke have concurrent hypertension. There is a strong association between increasing blood pressure and advancing age: 33 percent of persons in their 60s have elevated pressure, compared with 11 percent of those in their 30s (19).

Hypertension in the elderly is defined as blood pressure greater than 140/90 mmHg, or systolic blood pressure greater than 160 with normal diastolic blood pressure. Although persons over 75 are often underrepresented or excluded from research, limited findings indicate that control of moderate and high diastolic hypertension is also associated with reduced mortality and morbidity from CHD and stroke.

Isolated systolic hypertension (systolic pressure above 160 mmHg accompanied by diastolic pressure below 90 mmHg), which is found in 25 to 30 percent of persons over 75, is correlated with a twofold to threefold increase in mortality from CHD and stroke. The benefits of treatment are still under investigation; if therapy proves to be efficacious, treatment of this condition may reduce death rates or prevent these two diseases (33).

SMOKING

Cigarette smoking plays a significant role in mortality from cardiovascular disease. It is a significant factor in morbidity, exacerbating hypertension, which, in turn, is a risk factor for cardiovascular disease and stroke. Nevertheless, the elderly and persons working with and for them appear to share the belief that smoking cessation efforts are primarily of concern and importance to younger age groups (25). This is a false assumption for several reasons:

- Many elderly people live more than 10 and often 20 to 25 years beyond age 65. Many benefits of smoking cessation, such as increased pulmonary function, are experienced immediately, and others, such as reduced risk for lung cancer, begin as few as 2 years after smoking cessation. Increased life expectancy of the elderly thus justifies efforts to promote smoking cessation programs.
- Nicotine constricts blood vessels, thereby raising blood pressure (which is already elevated, on average, in older groups). For many elderly persons, elimination of smoking can effectively reduce their risk of stroke, which is the third leading cause of death for those over 65.
- Respiratory function can be improved immediately, even in patients with emphysema. Improvements in breathing are enhanced if a medically supervised program of moderate exercise is coupled with smoking cessation.
- Smoking reduces the ability to taste food. Because loss of this ability contributes to poor nutrition in the elderly, smoking can exacerbate poor eating habits.

Notwithstanding these cogent reasons for smoking cessation, most nonsmoking programs and research on smoking cessation are targeted to persons in younger age groups. Although these programs are important because of the great benefits of smoking cessation at younger ages, they should be expanded to give greater emphasis to their impact on the elderly.

EXERCISE

Although some research has shown an association, a definitive and direct link between physical exercise and reduction in risk of CHD and stroke has not been established. In addition, because research subjects have typically been younger men, evidence is still lacking for women and the elderly.

Despite gaps in knowledge of the benefits of exercise for the elderly in reduction of risk of CHD and stroke, several things are known about the effects of exercise that warrant implementation of moderate exercise programs. Regular exercise:

- increases lean body mass and reduces body fat (this effect has been associated with reduced CHD and diabetes in older persons);
- increases glucose tolerance (reduces the occurrence of diabetes or improves the functioning of those who are diabetic, a risk factor for CHD);
- increases the strength and speed of contractility in the heart muscle;
- increases oxygen uptake from the blood into the heart and skeletal muscles; and
- decreases heart rate and demand on the heart during rest.

Since exercise reduces other CHD and stroke risk factors, programs that encourage exercise in all age groups are important. Exercise can reduce the emotional tension associated with various diseases. In a study of men 50 and over, a 15-minute walk reduced neuromuscular tension more effectively than a dose of tranquilizer (10,11,12,17).

Exercise also reduces other CHD risk factors. It increases the proportion of high-density lipoproteins (HDLs) relative to low-density lipoproteins (LDLs),[1] but the effect is temporary; exercise must be performed at least every other day to maintain the reduction in LDLs and triglycerides. Blood-pressure reduction is more likely to occur in individuals with moderately elevated blood pressure and more likely to affect diastolic than systolic blood pressure. Enforced physical *inactivity* results in increased systolic blood pressure, increased total peripheral resistance, increased serum levels of cholesterol, and glucose intolerance, all of which are, in turn, risk factors for CHD.

Photo credit: Paul Conklin, Dancers of the Third Age, Dance Exchange, Washington, DC

Carefully developed exercise programs can benefit adults of all ages.

Notwithstanding its beneficial aspects, exercise can have certain risks. Risks and complications depend on a number of factors—the general health of the individual, past exercise habits, and age, as well as type, amount, and intensity of exercise. However, most authorities agree that the majority of adults under 65 do not need prior physical examinations before beginning a carefully developed, progressive exercise program. When weighed against the hazards of not exercising, the benefits clearly outweigh any risks (15).

STRESS

Stress is a normal part of life, but the inability to cope with it can cause health impairment. Two simple techniques, meditation and relaxation, can reduce the physical and psychological effects of stress. Meditation techniques have been found to reduce blood pressure and residual muscle tension and increase oxygen intake. There is an impressive body of research to substantiate the beneficial effects of relaxation training. These include reduction of elevated blood pressure, heart rate, and gastric motility, increased cardiac output and respiratory efficiency, and alterations in brain-wave patterns (increased ratio of alpha waves to beta waves in EEGs) (25).

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[1] High-density lipoproteins have two important functions: 1) they coat the inside of the artery walls and provide a protective layer to prevent fatty deposits from building up; 2) they help dissolve fatty deposits when they occur. Low-density lipoproteins are responsive to dietary habits and form dangerous deposits on the walls of blood vessels; LDLs are the primary culprits in clogged arteries and atherosclerosis. Thus the risk of CHD is reduced if the proportion of HDLs to LDLs is relatively high.

NUTRITION

Poor nutrition can be characterized by a lack of essential vitamins and nutrients, leading to deficiencies, or by an overabundance of certain nutrients that can be associated with higher risk for diabetes and high levels of cholesterol, both of which are risk factors for CHD and stroke.

Obesity (usually defined as greater than 20 percent over standardized tables of ideal weight for age and height) is associated with increased risk of hypertension, high cholesterol, and glucose intolerance. It is not clear, however, whether the risk factor is current obesity or a history of chronic obesity. If a longstanding history of obesity is shown to be correlated with CHD, an intervention program in the elderly might not be useful because the effects of the earlier obesity would be irreversible.

Diets low in saturated fats and high in vegetables and fiber are recommended for prevention of CHD. These diets can reduce blood pressure in normal subjects (31,32), but whether the incidence of CHD is reduced is unclear (19). Per capita consumption of foods high in cholesterol and saturated fats has decreased since the early 1960s, while consumption of foods high in unsaturated fats and fiber, like fish and vegetables, has increased (38). This change in dietary habits may have contributed to the recent drop in serum cholesterol levels and perhaps to declining CHD mortality. Large doses of the B vitamin, niacin, may reduce blood lipid levels (9) and seem to be helpful in reducing recurrent nonfatal myocardial infarction[2] (7).

High sodium intake has long been associated with high blood pressure (8), but there is as yet no conclusive evidence for a causal link. A recent epidemiological study of over 10,000 individuals aged 18 to 74 found that significant decreases in the consumption of calcium, potassium, vitamin A, and vitamin C were the nutritional characteristics that distinguished hypertensive individuals from those with normal blood pressure (24). Low calcium intake was most consistently correlated with hypertension. While these results do not prove causal effects, they do suggest directions for future research.

DIABETES AND IMPAIRED GLUCOSE TOLERANCE

Impaired glucose tolerance has been implicated as a risk factor for cardiovascular disease because of the high incidence of vascular complications in persons with diabetes mellitus. Fasting levels of blood glucose and the prevalence of adult-onset noninsulin-dependent diabetes rise with age. This change in blood glucose homeostasis is due in part to the age-related decrease of metabolically active lean body mass accompanied by an increase in fatty tissues. Because of these age-related changes, Williams (39) estimates that more than half of the population over 70 would be diagnosed as having diabetes according to the criteria used to evaluate younger adults in the oral glucose tolerance test. Standards for younger persons thus cannot be universally applied to the elderly.

Obesity is strongly correlated with impaired glucose tolerance: 80 percent of adult-onset diabetics are obese or have a history of obesity, and 60 percent of persons with 125 percent or more of ideal body weight have impaired glucose tolerance tests. Dietary guidelines developed by the American Diabetes Association (2) focus on the restriction of caloric intake and moderate increase in energy expenditure. Because diabetics have two to three times the risk of dying from atherosclerotic CHD as nondiabetics (3), a reduction in total and saturated fat calories is also recommended, and drug or insulin treatment may be necessary to reduce glucose levels. The efficacy of this treatment in the prevention of CHD is not proven, but trends suggest a favorable prognosis with long-term management of diabetes (19).

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[2] Myocardial infarction is death of tissue in the heart muscle due to insufficient delivery of blood or oxygen, usually due to obstruction of a blood vessel.

CHOLESTEROL

The link between lowered cholesterol levels and CHD became definitive only recently, although large studies have shown a consistent association between the intake of foods high in saturated fats and both the level of serum cholesterol and morbidity and mortality rates for atherosclerotic diseases. The National Heart, Lung, and Blood Institute confirmed this link in a study in which men 35 to 59 with very high levels of cholesterol were given drug therapy to reduce cholesterol. The incidence of CHD was significantly reduced in the men given the drug (37).

REHABILITATION

Rehabilitation or tertiary prevention after CHD usually includes exercise regimens with drugs, stress reduction, and various other techniques undertaken to prevent the recurrence of heart attacks. Research in these areas often excludes the elderly. The benefits of intensive rehabilitation after CHD are less well substantiated than the benefits of rehabilitation after stroke.

Interventions to minimize the effects of stroke and help patients to function independently are very important. The mean survival time after the occurrence of stroke is 7 years; 30 percent of patients survive 11 or more years. Results from the Framingham study indicate that following stroke, 33 percent remain dependent for activities of daily living, 20 percent require assistance with walking, and 15 percent require institutionalization. The remaining 35 percent are functionally independent. This level of functional disability is a significant drain on resources, both public and private.

Intensive rehabilitation after stroke is neither effective nor beneficial for all patients. Those who are unconscious during acute stroke are likely to remain dependent, while those who remain conscious and are able to walk unaided immediately after the stroke generally exhibit spontaneous functional recovery. Rehabilitation in a specialized stroke unit results in greater functional recovery; 52 percent of such patients exhibited functional independence as opposed to 32 percent of patients given traditional rehabilitation on the medical wards, and did so in a shorter period of time (average stay of 55 v. 75 days). The patients selected for this study had remained conscious during acute stroke, but exhibited developing or established hemiplegia (paralysis of one side of the body); they represent patients likely to survive but unlikely to recover spontaneously. Thus, the degree of impairment from stroke is a useful criterion for patient grouping. In addition to functional improvement, there are psychosocial and quality-of-life benefits (19).

Photo credit: Suburban Hospital, Bethesda, MD

Medically monitored physical activities are one form of rehabilitation or tertiary prevention.

Risk factors associated with cancer

Cancer is the second leading cause of death among the elderly. Several risk factors have been identified. For example, 30 percent of all cancer deaths may be attributed to smoking (13). Although it is not possible to accurately quantify the role of diet in cancer, 40 percent of cancer deaths among women and 57 percent of those among men may be associated with diet (13,27). There are synergistic effects between smoking and alcohol, but the effect of tobacco is far more important. Mortality from cancer of the cervix is decreasing, largely due to increased periodic screening with Pap smears. Cancers of the breast, ovaries, and endometrium account for 29 percent of all female cancer mortality (13 percent of total mortality).

Lung, colorectal, and prostate cancers are the most prevalent cancers among men; women are more at risk for breast, lung, and colorectal cancer, respectively. Some cancer death rates for elderly men have continued to increase, but the increase in rates for elderly women is a more recent phenomenon. This is especially true of lung cancer rates for women, probably due to the higher prevalence of smokers among women of recent generations. And although the incidence of cervical cancer has declined in the general population, it has not declined in women past menopause. Because older women may not visit gynecologists for regular checkups, primary care physicians should screen for cancer or, at least, refer women to gynecologists for evaluation (19).

Several types of cancers can be treated successfully if detected early enough. These include prostate (periodic physical exam), and breast and colon (discussion follows). Some evidence indicates a reluctance among the elderly to seek screening services or diagnosis; this is especially true of women who are at increasing risk of breast, cervical, and uterine cancer with advancing age. Some of this reluctance is due to misinformation about the possibilities for effective treatment.

BREAST

Breast self-examination is an effective, inexpensive way to increase the chance of early detection of breast cancer; 80 to 90 percent of primary breast cancers are detected by women themselves (19). The few self-examination programs that exist have concentrated on easy-to-reach populations, usually in work settings, leaving the relatively high-risk woman over 65 effectively out of reach. Only a few programs have been developed for these women. Some older women appear to be more reluctant to examine themselves and may not respond to certain teaching settings. Programs to educate them in self-examination techniques need to be tailored to their values and expectations. Annual mammography and physician examinations for women over 40 are associated with improved early diagnosis and significant decreases in cancer mortality.

There is a significant association between obesity and cancer of the breast and uterus in women, and cancer of the colon and prostate in men. High fat intake is also associated with breast cancer and prostate cancer, perhaps due to the effect on estrogen metabolism, imbalances of which are associated with increased risk of certain cancers.

COLORECTAL

The colon and rectum are the leading sites for overall mortality from cancer in those over 75. The 10-year survival rate for persons with localized cancer is 67 percent, compared with 36 percent for nonlocalized cancer. Since only 41 percent of all colorectal cancers are detected at a localized stage, early detection of this form of cancer is a high priority for prevention programs.

The guaiac test, and other simple tests of occult bleeding from the digestive tract, can be used in screening for colon and rectal cancers. But fewer persons over age 70 (27 percent) accepted an invitation to take a screening test than did younger persons (38 percent) in a recent study, although rates were low for both groups (19). The International Workshop on Colorectal Cancer recommends that the elderly undergo sigmoidoscopy every 3 to 5 years to screen for cancer (19).

Several dietary factors have been associated with cancer of the gastrointestinal tract. The dietary recommendations of the American Cancer Society (1984), though based largely on epidemiological and some experimental data, are meant to help reduce the risk of gastrointestinal and certain other cancers. These recommendations include: avoid obesity; reduce intake of fat, alcohol, and salt-cured, smoked, or nitrite-cured foods; and eat cruciferous vegetables and foods high in fiber and vitamins A and C.

Risk factors associated with fractures

The most important risk factors for fractures are osteoporosis and falls. The incidence of fracture rises dramatically with age: among women 75 to 79, the incidence of hip fracture is 6 per 1,000; among those 85 to 89 the incidence increases to 21.4 per 1,000; and among women over 90 the incidence rises to 48.6 per 1,000 (19).

OSTEOPOROSIS

Osteoporosis is estimated to cause about two-thirds of hip fractures in older people. The incidence of hip fractures resulting from osteoporosis was estimated at 98 per 100,000 in 1977, at a total annual cost for acute care of some $800 million. The number of hospital patient days resulting from these fractures is ranked 10th among conditions counted. The mortality rate from falls is estimated at 20 to 30 percent, with an additional 13 percent of survivors who never return to independent ambulation (23). Because 90 percent of fractures in older women are associated with little or no trauma, and in fact may occur simply because of osteoporosis (19), prevention of osteoporosis could sharply reduce the incidence of fractures among the elderly.

Current osteoporosis-prevention research centers on the effectiveness and possible risks of estrogen therapy after menopause, supplemental intake of calcium by women both before and after menopause, and the role of exercise in bone strengthening. Although estrogen replacement therapy after menopause seems to inhibit bone resorption, it has also been associated with increased risk of cancer of the uterine lining. Calcium absorption declines with age and can decrease by 30 to 50 percent by age 80 (18). The theoretical daily intake of calcium needed to counteract bone loss has been suggested as 1,000 mg for premenopausal women and 1,500 mg for postmenopausal women (18).

Blood levels of vitamin D, which promotes intestinal absorption of the calcium and phosphate involved in bone mineralization, are often deficient in the elderly and can be up to 50 percent lower than those of younger controls. These low serum levels of vitamin D may be due to reduced intake, reduced intestinal absorption, and/or decreased exposure to the sunlight that drives synthesis of the vitamin in the skin (30).

New evidence indicates that bone mineral content can be increased in older women by exercise. In a study of women whose mean age was 84, one group exercised (nonstrenuous exercise, sitting in a chair) 30 minutes a day, three times a week. This control group gained bone mineral content while an inactive group lost bone mineral content. Physical activity at any age may thus have a significant effect in reducing the effects of osteoporosis and the likelihood of fracture (34). (For further details see section on osteoporosis in ch. 3).

FALLS

The U.S. Public Health Service estimates that two-thirds of falls by the elderly may be preventable. The risk of fracture associated with falls increases with age, especially for women.

Falls are caused by both environmental and physical factors. As many as half of the falls sustained by the elderly may be caused by such environmental factors as loose, torn, or frayed rugs, poor lighting, icy sidewalks, or broken stairs. Poor vision (which is sometimes correctable), underlying physical conditions such as Parkinson's disease, seizures, cerebrovascular disease, and conditions that cause fainting or dizziness, also contribute to the incidence of falls. The incidence of falls could be reduced by more extensive diagnosis and treatment of these disease conditions and efforts to eliminate environmental obstacles.

Inappropriate or excessive medication—especially of sedatives, hypnotics, psychotropics, anticonvulsives, and antihypertensive agents—often causes falls. In one study, 93 percent of patients who were observed to fall between 10:00 p.m. and 6:00 a.m. had taken a barbiturate (19).

Risk factors associated with sensory loss

VISION

The prevalence of unattended treatable eye pathology rises dramatically after age 60, exceeding 85 percent of the elderly aged 65 to 74. Refractive problems increase less rapidly than cataracts, and cataract correction may be unduly delayed. Screening for glaucoma, which is effective, may be ignored by the elderly. The fragmentation and lack of coordination of services for the elderly, the needy, and the blind and partially sighted constrain the correction of visual problems among the older population (19).

TASTE

Age-related changes in, for example, the gastrointestinal tract may impair food intake, digestion, and absorption of certain nutrients (see app. C). The sense of taste itself changes with age, and this can lead to malnutrition. Compounding the risk of malnutrition is the fact that current Recommended Dietary Allowances (RDAs) of various nutrients consider the elderly as a single 51-and-over age group, despite wide disparities in individual and age-related nutritional needs.

HEARING

Hearing loss affects the ability to function independently, affects communication, and can lead to a medical diagnosis of cognitive impairment. The prevalence of hearing impairment is 28 percent in persons over 65 and about 40 percent in those over 75 (see OTA background paper on Management of Hearing Impairments in the Elderly). Although many hearing impairments are not correctable with current technologies, simple hearing aids to amplify speech can be very effective in some cases. Hearing aids are expensive, difficult to adjust, not reimbursed by Medicare, and often fraudulently marketed; all of these factors lead to neglected, treatable hearing problems in the elderly.

Risk factors associated with dental disease

In 1971 about 45 percent of Americans over 65 were estimated to have lost all of their teeth (36). Dental caries and periodontitis are the justification for 90 percent of extractions. Dental disease can limit the food choices and eating practices of the elderly and damage their self-image and social confidence. Clinical studies done in the 1940s reported a high prevalence of vitamin C and B-complex deficiencies among edentulous (lacking natural teeth) elderly, but need to be updated (16,22).

Both nutritional and hygienic practices have been implicated in dental disease. The intake of starches and simple sugars is known to aggravate decay and increase the risk of loss of teeth (4). Intake of simple sugars increased during the early years of this century, while intake of the more nutritious complex carbohydrates declined from 43 percent (1909) to a current 29 percent of dietary food energy (28). Periodontal disease, or recession of the gum and resorption of the bone surrounding the roots of the teeth, is probably related to general age-related loss of bone mass (see section on osteoporosis); possible prevention and treatment of this disease through dietary calcium supplements warrants further exploration.

Despite the impact of dental disease on the elderly, 48 percent of those who still have teeth have not visited a dentist within the last 5 years (6). Because routine dental examinations are not covered by Medicare or most private health insurance, a major obstacle for the elderly may be cost.

Nutritional deficiencies

There are few reliable data on the prevalence of frank or "subclinical" nutritional deficiencies among the elderly. However, it is known that the elderly are particularly susceptible to malnutrition because of the physiological and behavioral changes of aging, and increased prevalence of chronic disease. For example, age-related changes in the gastrointestinal tract may impair intake, digestion, and absorption of certain nutrients. Psychosocial changes associated with aging, such as senile dementia, isolation, and depression may also suppress appetite and increase the risk of nutrient deficiency (see app. C).

Subclinical malnutrition is difficult to diagnose, both because physicians may not be aware of it and because not enough is known about adequate nutritional levels for the elderly. Current RDAs for the elderly are based on survey and research data from younger groups that have been extrapolated to the entire over-50 population, which is an extremely heterogeneous group. Direct study of the special nutritional needs of those in age groups over 65 is needed to provide better standards for medical care, food assistance programs, and national nutrition surveys.

The Federal Government has attempted to ameliorate the problem of malnutrition among "high risk" segments of the population, including the elderly, through federally sponsored food assistance programs (see table C-8 in app. C). An estimated 1.9 million elderly persons are now enrolled in congregate and home-delivered meal programs (29), but the food stamp program remains the largest program affecting noninstitutionalized elderly persons (1). In fiscal year 1981, for example, an average of 22.4 million people received food stamps each month. Because currently available evaluations of federally funded food assistance programs that serve the elderly are inconsistent and flawed, they yield little information about dietary and health benefits of these programs. There is general agreement, however, that they are not reaching certain target groups, especially minorities and the socially isolated (see app. C).

Photo credit: Suzanne L. Murphy

Federally subsidized congregate meal programs for the elderly help assure adequate nutrition and promote social interaction.

The Federal Government could effectively promote preventive nutrition through intensified public education. Inasmuch as eating habits are established early in life and many risk factors for age-related conditions are cumulative throughout adulthood (as for CHD and osteoporosis), such nutrition education should be targeted to all adults, not just the elderly.

Conclusions

The central issues in health promotion and disease prevention strategies for the elderly are the efficacy and the cost effectiveness of particular interventions. Further, many of the risk factors require behavior modification and are ultimately the personal responsibility of the individual. Improved quality of life is also important in that many interventions, while they do not significantly alter health statistics, have an effect on functional independence. This quality-of-life factor is often not considered in the present structure of Medicare/Medicaid reimbursement.

The overriding Federal issue is the reimbursement structure of the present Medicare/Medicaid system. At present, reimbursement is principally for acute care, and payments are prohibited for all or most preventive services (exceptions: immunization against pneumococcal pneumonia and short-term rehabilitation). Many relatively inexpensive preventive measures are not reimbursed, yet the consequences of not applying these measures in fact increase overall Medicare costs. A rethinking of reimbursement categories may, therefore, be in order. Preventive services that are directly linked to reduction in need for acute care but are not presently reimbursed include:

- *Periodic screening.* Among the preventive measures effective here are screening for hypertension, and breast and colorectal cancer. Mammography exams are not reimbursed, but acute care for breast cancer is. The occult blood test, a very simple and inexpensive test for detection and early diagnosis of colorectal cancer, is not reimbursed. Blood-pressure control is an achievable goal because hypertension is easily detected and usually correctable. Although treatment of hypertensives must be carefully monitored to avoid iatrogenic problems, reduction in blood pressure is a significant factor in lowering stroke and overall mortality rates in the elderly population. The prevalence of hypertension in persons aged 65 to 74 dropped from 49 to 41 percent in the 1960s and 1970s; the CHD death rate in this group showed a similar decline during this period (35).

- *Long-term care*. There is only minimal reimbursement for tertiary prevention, which could aid in increasing functional independence and thus reduce costs of long-term care and related services (see discussion in ch. 7) (25,35).
- *Vision*. Refraction is not reimbursed, yet visual problems are a major component of falls. (Trauma related to falls is reimbursed).
- *Drug and alcohol abuse*. Treatment is not generally reimbursed. When untreated, these conditions can lead to nutritional problems and to increased mental confusion that mimics senile dementia (see OTA Case Study on the Effectiveness and Costs of Alcoholism Treatment for "Medical Technology and Costs of the Medicare Program").
- *Hearing*. Hearing loss can be a risk factor for injuries and falls, and purchase of hearing aids is not reimbursed (for further information, see the OTA Background Paper on Management of Hearing Impairments in the Elderly).
- *Dental care*. Lack of dental care has both direct effects on health—the occurrence of periodontal disease—and indirect effects in that the individual's opportunity to maintain adequate nutritional levels is compromised. Lack of teeth, or poor teeth, may also lower self-esteem.

Medicaid does pay some of these preventive costs, but eligibility criteria differ from State to State. Billions are being spent for acute care, yet relatively little reimbursement is allocated to prevention, which could potentially reduce these acute care costs. Some evidence of potential savings exists, but there is no available hard evidence of potential levels of cost reduction. Measures for research on the degree to which prevention could reduce acute care costs in the elderly are thus sorely needed. (Note: A proposal for a separate health promotion/disease prevention section of the National Institutes of Health has recently been passed by the House. See ch. 3.) The irony is that while some research is underway, growing numbers of Americans are failing to avail themselves of proven preventive measures—e.g., smoking cessation, diet modification, exercise—and in so doing, increasing the likelihood that they will someday need acute care. The obvious goal is to keep people healthy and functionally independent until they die at a "late" age. How to allocate health care delivery and research resources for prevention is an important component of achieving this goal.

Improving the nutritional status of the elderly clearly calls for establishing nutritional RDAs for subgroups of people over 50. Once these data are available, educational efforts targeted to both the elderly and health care providers can be more effective. But there is little accurate or reliable information on the dietary benefits that these programs provide for the elderly. In general, participants are nutritionally better off than nonparticipants, but food programs are not always reaching target groups, especially the poor and minority elderly.

Congressional issues and options

There is growing evidence that the amelioration of specific risk factors can reduce the incidence of the three leading causes of mortality—coronary heart disease, cancer, and stroke. It is also known that specific actions can be taken, especially among the elderly, to reduce the probability of other causes of morbidity and mortality, such as falls and fractures. Many of these measures can not only reduce the incidence of specific diseases but can improve the quality of life. At present, Medicare reimbursement is principally for acute care and prohibits payment for all or most preventive services (exceptions: immunization against pneumococcal pneumonia and short-term rehabilitation). Although many relatively inexpensive preventive measures are not reimbursed, the consequences of not applying these measures are usually more costly to the Medicare system. These measures include screening for hypertension and for breast, cervical, prostate, and colorectal cancers; refraction for visual problems; treatment of drug and alcohol abuse; provision of hearing aids; and dental care.

ISSUE 1: Does research indicate that health promotion interventions are cost effective?

Research on the cost effectiveness of various health promotion/disease prevention strategies is in its infancy. Options available to Congress include:

Options:

1.1: Congress could maintain the status quo.

1.2: Congress could increase its level of involvement in aging research and stipulate that cost effectiveness be a part of new health promotion research within the National Institutes of Health.

The advantages and disadvantages of greater or lesser congressional support of biomedical research and greater or lesser direct involvement with the direction of such research are discussed in chapter 8. Inasmuch as some research is being undertaken in health promotion, more evidence of the cost effectiveness of various interventions will emerge even if the status quo is maintained. But if Congress were to stipulate that some of this research be devoted to potential savings in the cost of acute care because of health promotion interventions by the prevention offices within NIH, reformulation of Medicare reimbursement categories could proceed more swiftly.

ISSUE 2: Should Medicare reimbursement categories be reconsidered with a view to increased reimbursement for health promotion/disease prevention interventions?

Direct links between particular interventions and the occurrence of morbidity and mortality, and the costs of these interventions compared to those for acute care, are not clearly established. It is known, however, that the potential for cost savings in acute care is significant.

Options:

2.1: Congress could maintain the status quo.

2.2: Congress could adopt option 1.2 above and stipulate that results from these studies be considered by the Prospective Payments Commission.

In maintaining the status quo, research in health promotion would continue and some of these research results might be incorporated into clinical practice activities. For example, research could be initiated to determine the cost effectiveness of fixed-fee payments to physicians who carry out specific preventive services. If the second option were to be adopted, Congress could ensure that results were considered as soon as they became available. One advantage of this approach is that in the case of some health promotion interventions (e.g., cancer screening and correction of vision and hearing problems), it may be relatively easy to quickly demonstrate that simple interventions for specific conditions are cost effective by comparison to later costs for acute care. One disadvantage of this option is that the mandate for the Prospective Payments Commission would have to be changed, since it currently is concerned only with hospital costs.

ISSUE 3: How could Congress obtain more accurate and standardized evaluations of Federal food assistance programs in order to improve their efficacy?

Most currently available evaluations of Federal food assistance programs fail to use representative samples, longitudinal data, and biochemical tests to accurately establish the nutritional status of participants and possible benefits of the program meals. Many examine neither the efficacy of the mandated nutrition education nor the qualifications of the meal program staff. Findings of many evaluations are consequently limited, inaccurate, and cannot be compared with those of other evaluations.

Options:

3.1: Congress could require standardized evaluation techniques for Government-contracted surveys *of food assistance programs. Such techniques would involve standardized biochemical and anthropometric (and, if possible, longitudinal) determinants of nutritional status, representative samples, and better evaluations of both program staffs and the quality of the nutrition education offered to program participants.*

3.2: Congress could establish funding incentives or other sponsorship for private investigators who use such standardized techniques.

3.3: Congress could mandate that the Health and Nutrition Examination Survey (HANES) include age groups over 74 and that it include a sample of elderly food program participants to be compared with the general population.

Presumably, investigators contracted by the Government would improve their techniques for evaluating food assistance programs after seeing the flaws of past evaluations. Conversely, the lack of accurate, comparable data about such a large government program may be serious enough to warrant development of specific guidelines and requirements for federally contracted evaluations that would create a pool of comparable information. There is a dearth of reliable data on the efficacy of the programs in terms of nutritional impact, nutrition education, and the level of food management training required of meal-site employees.

ISSUE 4: How could Congress approach the failure of the meal programs to reach certain target groups?

Many surveys find that food assistance programs, including food stamps, are inadequate to reach some of the target groups specified in the programs' original congressional mandate. For example, persons aged 60 to 64 are at present ineligible for food stamps and most meal programs operate only 5 days a week. While low-income groups seem to be represented among participants, minorities and the socially isolated are not well represented. This could be due to public ignorance of the programs, inaccessibility of the programs to these underrepresented target groups, or voluntary lack of participation.

Options:

4.1: Congress could require the Administration on Aging to develop guidelines and materials for targeting educational information on food assistance programs to the most needy groups.

4.2: Congress could require that local programs actively seek out the most needy, especially within the underrepresented target groups, within a given community.

4.3: Congress could mandate quotas for target groups according to local demographic characteristics of each program site or area.

4.4: Congress could mandate that the Administration on Aging and the National Institute on Aging prepare and disseminate health and nutrition education materials to consumers.

There is disagreement as to whether lack of participation in meal programs is a result of ignorance of the programs or lack of mobility. Efforts to educate would be costly but might encourage the most needy in the community to gravitate toward the food assistance programs. There is some evidence that some active intervention on the Government's part is necessary in both education and mobility to ensure that these mandated target groups are served.

RESEARCH PRIORITIES

Current Recommended Dietary Allowances (RDAs) for the elderly fail to take into account the age-related physiological, behavioral, and pathological changes that can affect their nutritional needs. Certain nutrients are especially relevant to the aging process and should be stressed in research on elderly nutrition; these include calcium, vitamin D, B vitamins, vitamin A, zinc, sodium, and fats.

Technical memorandum

The OARS assessment battery yields information on five functional activity areas:

- social resources, quantity and quality of relationships with friends and family, and availability of care in time of need;
- economic resources, adequacy of income and resources;
- mental health, extent of psychiatric well-being, cause of existing disorder, if any;
- physical health, presence of physical disorders, participation in physical activities; and
- activities of daily living, capacity to perform various instrumental and physical (or bodily care) tasks that permit individuals to live independently (for other measures, see ref. 20).

Another approach uses clinical and epidemiologic criteria to identify specific health goals and professional services appropriate for 10 different age groups from birth to 75 years and over. For example, the goals for the elderly (60 to 74 years) are as follows:

- to prolong the period of optimum physical/mental/social activity,
- to miminize handicapping and discomfort from onset of chronic conditions, and
- to prepare in advance for retirement.

The professional services are:

- professional visits with the healthy adult at age 60 and every 2 years thereafter, including the same tests for chronic conditions as in older middle age, and professional counseling regarding changing lifestyle related to retirement, nutritional requirements, absence of children, possible loss of spouse, and probable reduction in income as well as reduced physical resources;
- annual immunization against influenza;
- annual dental prophylaxis; and
- periodic podiatry treatments as needed (5).

Another approach that stresses functional independence has the following criteria:

- the ability to perform activities of daily living, i.e, bathing, dressing, toileting, transfer, continence, and feeding;
- degree of mobility of the individual, including the capacity to move about within the home, the immediate neighborhood, and the larger community;
- mental state of the individual: cognition, psychological level of functioning, and the ability to cope emotionally with problems of daily life; and
- nature of the social and economic environment and the degree of support it offers (20).

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Chapter 5

Medications and the Elderly

Contents

Page
Introduction 137
Use of Medications Among the Elderly 137
  Biologic Differences in Drug Effects and Metabolism in Older People 140
  Altered Metabolism and Tissue Sensitivity 140
  Characteristics of Drug Use 141
  Side Effects and Adverse Drug Interactions 141
  Patient Compliance With Drug Prescriptions 143
  Issues Specific to Drugs Affecting Mental Function 145
  Need for Increased Education of Health Care Providers 145
  Use of Over-the-Counter Drugs 146
  Patient Information on Drugs 146
Congressional Issues and Options 148
Chapter 5 References 153

Tables

Table No. *Page*
10. Comparison of Inflation Factors for Prescription Drugs and Other Goods 140
11. Age-Related Changes Altering Drug Metabolism and Sensitivity 140

Figures

Figure No. *Page*
18. Percent Change in Prices From Previous Year 139

Chapter 5

Medications and the Elderly

Introduction

Drug treatment is an important medical technology[1] that is especially important to the elderly population. Medications are widely used by older Americans, and Federal policy directly affects the availability of drugs for general use. The safety of using medications, availability of information about drugs, and new technologies that might improve how drugs are delivered and used are covered in the following chapter.

Congress has demonstrated an interest in issues related to use of medications by older Americans. A joint hearing was held in June 1983 by the Senate Special Committee on Aging and the Subcommittee on Health and Long-Term Care of the House Select Committee on Aging entitled "Drug Use and Misuse: A Growing Concern for Older Americans" (70). That hearing covered many of the issues raised in this chapter.

A number of other medical technologies from this report have been excluded because they are covered in other OTA reports. One area deserves special mention—that of medical devices. There is a vast potential for medical devices that improve function and enhance independence among disabled elderly individuals. Some of these devices are reviewed in the section on *Long-Term Care* in chapter 7. Others have been assessed in recent OTA reports, such as *Technology and Handicapped People,* as noted below, or are currently the subject of other OTA projects. Devices specifically relevant to urinary incontinence and hearing impairments are reviewed in case studies on those subjects to be published separately. Among the current OTA assessments that cover relevant technologies, such as diagnostic and therapeutic procedures, are:

- *Federal Policies and the Medical Devices Industry* (October 1984),
- *Medical Technology and the Costs of the Medicare Program* (July 1984),
- *Postmarketing Surveillance of Prescription Drugs* (November 1982),
- *Medical Technology Under Proposals To Increase Competition in Health Care* (October 1982),
- *MEDLARS and Health Information Policy—A Technical Memorandum* (September 1982), and
- *Technology and Handicapped People* (May 1982).

Use of medications among the elderly

More than four out of five Americans over 65 now suffer from one or more chronic diseases (86 percent—see chs. 7 and 9 and app. A). About 85 percent of the noninstitutionalized elderly and 95 percent of those in hospitals, nursing homes, and other institutions take medications on a regular basis (39). Although those over 65 constitute 11 percent of the population, they use 30 percent of prescription drugs (54,64), more than twice as many as the average user (7,39). An average of 10 different drugs is prescribed for an elderly patient during each hospital stay; the usual number of prescriptions for those in nursing homes is 4 to 7 (54). The average number of prescriptions for those who use drugs and are over 65 rose from 13.4 per year in 1967 to 17.9 in 1977; 90 percent of these prescriptions are for long-term use to treat chronic medical conditions (37).

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[1] The definition of technology used by OTA is "a drug, device, or medical or surgical procedure used in medical care."

As disease prevalence rises with age, drug use increases. Older individuals take medications for several types of illnesses. They use the everyday drugs used by the general population for colds, acute infections, and headaches. Such chronic diseases as arthritis, hypertension, and cardiovascular disorders, which are especially common in older people, determine the use of another group of drugs that includes diuretics, anti-hypertensives, anti-inflammatory agents, and cardiac drugs (60).

Elderly women suffer disproportionately from drug-related problems. They live longer, are more likely to live alone (almost twice as likely as men), and have lower average incomes and a higher prevalence of disability than men. Each of these factors complicates drug therapy. The oldest women are the most vulnerable to adverse reactions and other untoward consequences of using drugs.

Drug use improves the condition of most elderly patients; drugs are used because they work. Patients are better off because useful drugs are available, and drugs are "probably the most cost-effective modality of chronic disease management" (36). While the rate of inflation for medical costs *overall* during the last decade has been far greater than for the economy as a whole, pharmaceutical prices have risen more slowly than the Consumer Price Index (CPI) (19). Inflation for pharmaceuticals has exceeded the CPI in recent years (fig. 18), but the average inflation over the past decade remains favorable (table 10). Pharmaceutical therapy is not only medically effective but can also produce savings by diminishing morbidity and forestalling the need for more expensive forms of medical treatment. For example, the use of cimetidine (Tagamet®) for duodenal ulcer disease led to an estimated 26- to 70-percent cost savings for Medicaid in Michigan in the first year of its use, primarily by substituting for surgery in some patients (18). It is not clear that this figure can be extrapolated specifically to the elderly population, because the study included all age groups, but the potential for cost savings over the short term has been demonstrated for the general population in this study. In another example, lithium treatment of manic-depressive illness has saved an estimated $4 billion over the last decade, according to the director of the National Institute of Mental Health (56).

Use of drugs to treat diseases for which there has never previously been effective therapy can, however, increase health care costs, if their cost is higher than previous modes of therapy. Treatments requiring extensive drug therapy may also increase overall costs.

Many issues concerning the cost effectiveness of drug therapy, proper indications for drug use, and regulatory practices vis-à-vis the drug industry are not directly relevant to this report, because they do not specifically affect the older population. Although these issues are important for older Americans because they use more drugs, policy changes would not be directed at improving the lot of the elderly per se. The balance of this chapter thus deals with those aspects of drug therapy that do specifically affect the older American population. The issues to be discussed include metabolic and clinical differences between older and younger individuals, drug testing regulations, and patterns of drug use unique to the elderly.

Older Americans pay more for prescription medications than does the general population. Those over 65 pay an average of $93 per year for prescriptions, compared to $79 for those 55 to 64 and $27 for those 19 to 24 (27). Cost differences are especially marked in the heaviest users: 3.3 percent of those over 65 pay more than $250 per year for prescription drugs, compared to 2.2 percent of those 55 to 64 and 0.5 percent of those 19 to 24 (27). Some contend that these figures substantially underestimate the economic impact of drug use among the elderly, because such figures do not capture over-the-counter medications, and do not measure the impact of a substantial minority of elderly patients who have medication bills far in excess of $250 (37). The important topic of reimbursement policy for prescription drugs under Medicare has been omitted because it has been analyzed in detail in a recent report which gives potential costs of changes in Medicare reimbursement policy and cost estimates for a variety of options (65).

Many of the problems of drug use among the elderly are due to altered metabolism, the pres-

Figure 18.—Percent Change in Prices From Previous Year (based on table 10)

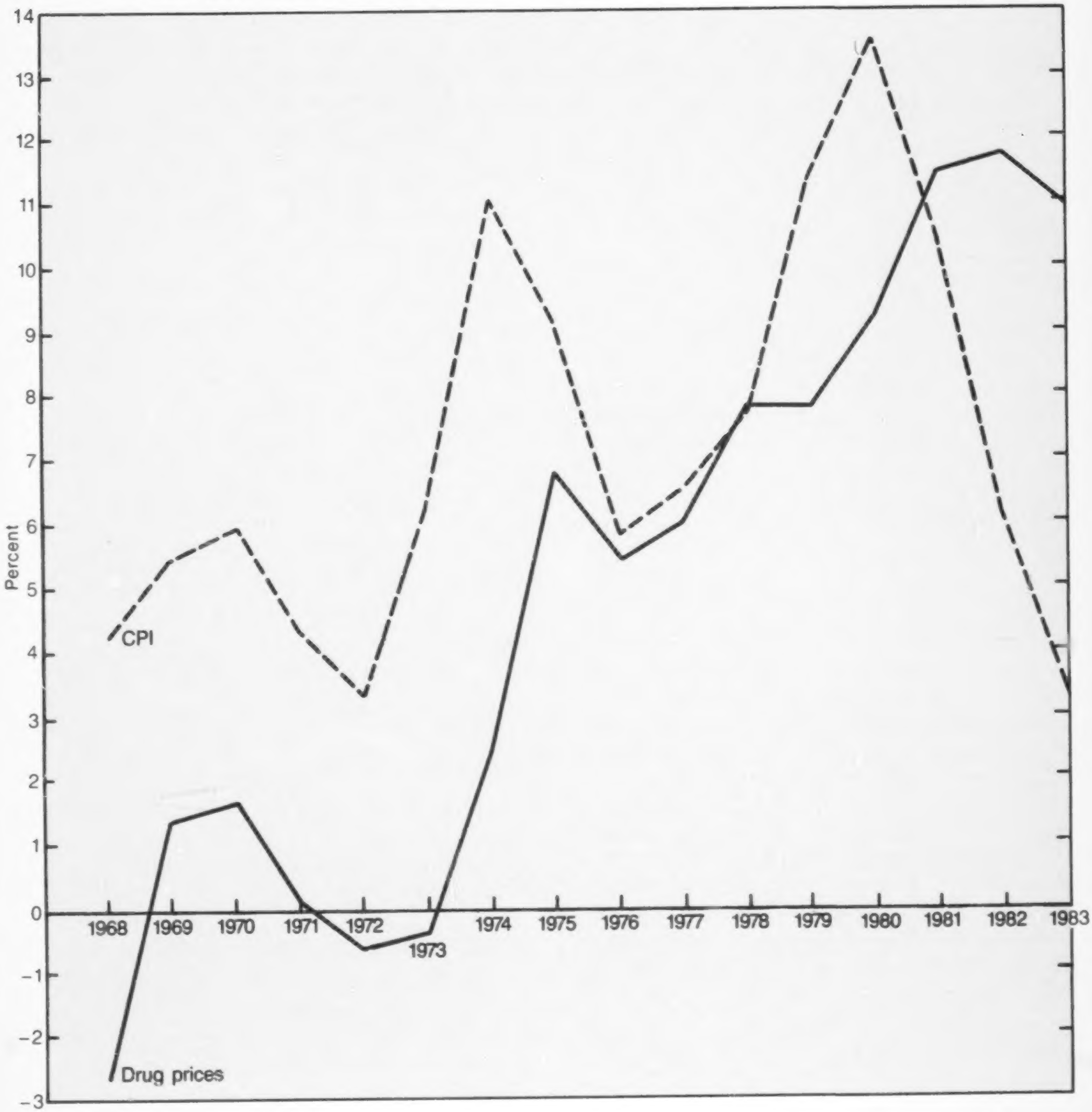

Table 10.—Comparison of Inflation Factors for Prescription Drugs and Other Goods

Year	Prescription Drug Price Index	Consumer Price Index for all goods
1967	100.0	100.0
1968	98.3	104.2
1969	99.6	109.8
1970	101.2	116.3
1971	101.3	121.3
1972	100.9	125.3
1973	100.5	133.1
1974	102.9	147.7
1975	109.3	161.2
1976	115.2	170.5
1977	122.1	181.5
1978	131.6	195.4
1979	141.8	217.4
1980	154.8	246.8
1981	172.5	272.4
1982	192.7	289.1
1983	213.8	298.4

SOURCE: Bureau of Labor Statistics, cited by Palumbo, 1984 (55).

ence of multiple diseases, the use of multiple drugs, and increased susceptibility to side effects.

Biologic differences in drug effects and metabolism in older people

Drugs are tested for side effects and therapeutic effectiveness in the general population, yet are used most often by the elderly, in whom they may act in a manner not always detected in studies of the general population. Recent studies of pharmacokinetics—the study of how drugs are distributed and metabolized in the body—and pharmacodynamics—the study of how drugs act—show significant differences between older and younger populations. These differences are based on fundamental biological age-related changes that affect the body's ability to process, store, and excrete drugs (table 11).

Biological differences between older and younger patients are analogous to the differences between adults and infants. It has been said that just as it took many years to recognize that infants are not simply "smaller" adults and must be treated differently, it is not yet universally recognized that the elderly require different treatment than younger adults (33).

Table 11.—Age-Related Changes Altering Drug Metabolism and Sensitivity

- I. **Body composition**
  - A. Decreased lean body mass
  - B. Increased proportion body fat
  - C. Decreased total body water
  - D. Decreased blood albumin (small change)
- II. **Heart and blood vessels**
  - A. Decreased heart response to stress
  - B. Increased size of heart
  - C. Diminished vessel elasticity
  - D. Increased total vascular resistance to blood flow
  - E. Decreased oxygen delivery to selected organs
    - Kidneys
    - Liver, brain, and muscles (small change)
- III. **Kidneys**
  - A. Decrease in number of blood filtering units (nephrons)
  - B. Decreased blood flow through kidneys
  - C. Decreased filtering and clearance rate of blood components
  - D. Decreased ability to adapt to maximum loads
- IV. **Digestive organs**
  - A. Slowed stomach emptying
  - B. Diminished acid secretion
  - C. Decreased peristalsis
  - D. Decreased absorption (small change)
- V. **Liver**
  - A. Altered drug metabolism (slowed oxidation, especially in men, conjugation relatively unaltered)
  - B. Diminished blood flow (small change)
- VI. **Nervous system**
  - A. Decreased threshold for depressant medications
  - B. Decreased coordination and short-term memory (small change, unless another disorder is also present)
  - C. Diminished blood flow to brain and nerves (slight, in absence of vascular disease)
  - D. Slowed velocity of conducting impulses in nerves
  - E. Slowed reflexes
- VII. **Lungs**
  - A. Decreased lung elasticity
  - B. Decreased effective surface area for oxygen exchange
  - C. Decreased effective breathing volume
  - D. Decreased rate of expelling air
  - E. Decreased clearance of irritants (ciliary movement)
- VIII. **Endocrine organs**
  - A. Decreased sex hormones (in general, with a few exceptions)
  - B. Decreased response to sugars
  - C. Many other alterations, too numerous to list, including stress hormones, regulators of metabolic rate, and body volume regulation

SOURCE: Lamy, 1982 (33), as modified by OTA with the assistance of J. Rowe.

Altered metabolism and tissue sensitivity

Older adults have significantly altered drug reaction and metabolism (7,20,33,36,38,43). They also have a higher percentage of fatty tissue compared to lean body mass, which causes increased effective concentrations of water-soluble drugs and prolonged retention of fat-soluble drugs. Hepatic metabolism of drugs, particularly oxidative processing in older males, is altered with age, which may lead to reduction of the required dose of drugs so processed. Decreased kidney function with age leads to prolonged retention of drugs in the body, often lowering the dose of a drug required to achieve useful concentrations, or necessitating an increase in the time between doses. Decreased blood albumin causes increased effective plasma concentrations of many drugs.

Tissue sensitivity to drugs may also increase or decrease with age, depending on the tissue, the patient, and the drug. Many of these changes lead to a need for reduced doses of drugs. The clinical effect of many benzodiaepine drugs (common sedative agents) in older patients, for example, is more intense than in younger patients with similar blood concentrations (47).

Prescription sleeping pills provide striking examples of how altered biological characteristics can necessitate adapting the treatment to the older patient. Common sleeping pills, also called minor tranquilizers or hypnotics, are fat-soluble chemicals that are retained longer in older patients: flurazepam (Dalmane®, a hypnotic agent) stays in an elderly patient for an average of 1 week (64), and the effective half-life of diazepam (Valium®, a related anti-anxiety agent) averages 90 hours in those over 80, compared to 20 hours in those under the age of 20 (23). These prolonged retention times have led geriatric pharmacologists to urge the prescription of shorter acting drugs at lower doses.[2] Although it is twice the recommended geriatric dose, the usual 5 mg dose of Valium® (diazepam) is one of the most commonly prescribed drugs for those over 65 in a private prescription service (29), and more than 13 million prescriptions for Dalmane® (flurazepam) were given to the elderly last year (64). Such figures do not indicate that the drugs are not useful, but do suggest that prescription patterns are not optimally tailored for the needs of the older population.

Characteristics of drug use

Those over 65 use more drugs than any other age group (36,43). Many chronic disorders such as arthritis or hypertension are treated with more than one drug. Many older people have multiple chronic diseases, each of which may be treated by drugs. There are more than 43,000 pharmaceutical products on the market, containing 1,900 separate chemical entities (39). The scant attention given to use of drugs peculiar to the elderly in medical practice is due in part to the fact that much drug information (e.g., information in the Physician's Desk Reference) is based on Food and Drug Administration (FDA) requirements for drug certification. At present, FDA drug approval does not require special attention to effects on elderly patients. (See "Drug Testing" below.)

Side effects and adverse drug interactions

The elderly have a higher incidence of drug side effects and drug interactions (2,20,33,38). The threshold of toxic blood concentration is lower among the elderly for many drugs, leading to increased probability of overdose. The presence of multiple chronic diseases and their treatment with multiple drugs lead to a higher incidence of adverse drug reactions and adverse drug *interactions* (36,43,58). This may be due not only to altered pharmacokinetics, but also to possibly increased susceptibility to adverse effects of drug usage resulting from altered inherent susceptibility among older people.

A recent study of adverse drug reactions and interactions, which showed that they accounted for 3 percent of all hospital admissions, found this figure to be much higher for the elderly—12 to 17 percent of hospital admissions for those 70 to 90. Of those suffering adverse drug reactions, 40 percent are over age 60 (cited in 54). Conclusions from the studies that have been performed cannot be generalized to the total American elderly population because they have been small and local. Generation of aggregate data on hospital admissions due to drug reactions is one benefit that may accrue from increased use of computerized medical information systems, and may permit more accurate policy determinations.

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[2] The use of very short-acting hypnotic agents is also problematic, in that patients may awaken from "rebound insomnia" if the drug is metabolized and cleared rapidly. Resolution of proper practice in prescribing hypnotic agents thus awaits further inquiry.

Adverse effects are especially common for drugs used to treat cardiovascular and psychiatric diseases and so are used especially heavily by the elderly. Adverse drug reactions among the elderly have been roughly estimated to cost $3 billion per year (cited in 54).

Some assert that side effects of drugs may be more common among ambulatory patients than among hospital patients (33). Reporting of adverse effects is less reliable for ambulatory patients, and drug errors are more common outside the hospital. Increased home care may exacerbate the problem of adverse drug effects and noncompliance with prescription instructions.

A different type of problem in geriatric drug use is the frequency of drug interactions. Drug interactions can occur between the drug and the patient (due to individual susceptibility), between the drug and numerous diseases (metabolism of drugs for one disorder altered by another disorder), between the drug and drugs for other disorders, and between the drug and a patient's diet.

Interactions between drugs and diet can cause problems in several ways (34). Drugs can affect dietary intake; certain antacids, used to quell stomach complaints, also lead to decreased absorption of phosphate, vitamin B_1 (thiamine), and iron (needed to make red blood cells) (42). Laxatives, often used to prevent constipation, can prevent the absorption of fat-soluble vitamins involved in blood coagulation and bone metabolism (see section on *Nutrition* in ch. 4). Dietary habits can also influence the efficacy of drugs; diets high in yeast, liver, fish, whole grains, and certain vegetables can inhibit the effectiveness of drugs for Parkinson disease. Diets high in vitamin K, such as spinach, cheese, and liver, can reduce the efficacy of some drugs used to prevent blood clot formation (42). Foods high in the chemical tyramine, found in cheese, wine, and chocolate, can cause dangerous elevation of blood pressure for those taking some types of anti-depressant medications. Such problems are not unique to older patient populations, but each of these drug groups is used more by elderly individuals (42).

Although many drug interactions cannot be avoided, the increase of "polypharmacy," the simultaneous use of multiple drugs, highlights current deficiencies in the use, retrieval, and storage of medical information. The problem of predicting and reporting drug interactions is an example; one computer analysis of drug prescriptions showed the potential for harmful drug interactions to be far in excess of those clinically reported (8). Present methods of monitoring adverse drug effects raise questions of whether untoward reactions are markedly underreported or whether the computer model is incorrect; both explanations may be partially valid.

Technology can be useful in identifying drug interactions. A recent study that used a computerized prescription information service found that using the computer did not reduce the number of prescriptions with potential problems, but did shorten the time period needed to recognize and begin dealing with the problem (30). The application of sophisticated "artificial intelligence" to medical monitoring, in which computer programs, such as the RX program developed at Stanford University, (9,10) continuously investigate the patient record data base of a hospital or region, looking for possible medical effects from the use of a particular drug or group of drugs, is likely to be a major improvement. Such data analysis depends, however, on gaining access to statistics on the incidence of drug side effects in the population. Innovations arising from increased use of information technologies, such as "smart cards" or improved patient-centered information systems may enhance the ability to identify drug reactions and interactions. The present system, which relies largely on user, manufacturer, or physician reporting, requires that someone *notice* a causal relationship, and is especially unreliable when there is a long time lag between the start of drug administration and the development of an adverse effect (8,67). Development of effective methods of monitoring drug use in actual clinical practice may prove important in development of drugs for the elderly population. (See *Drug Testing* below.)

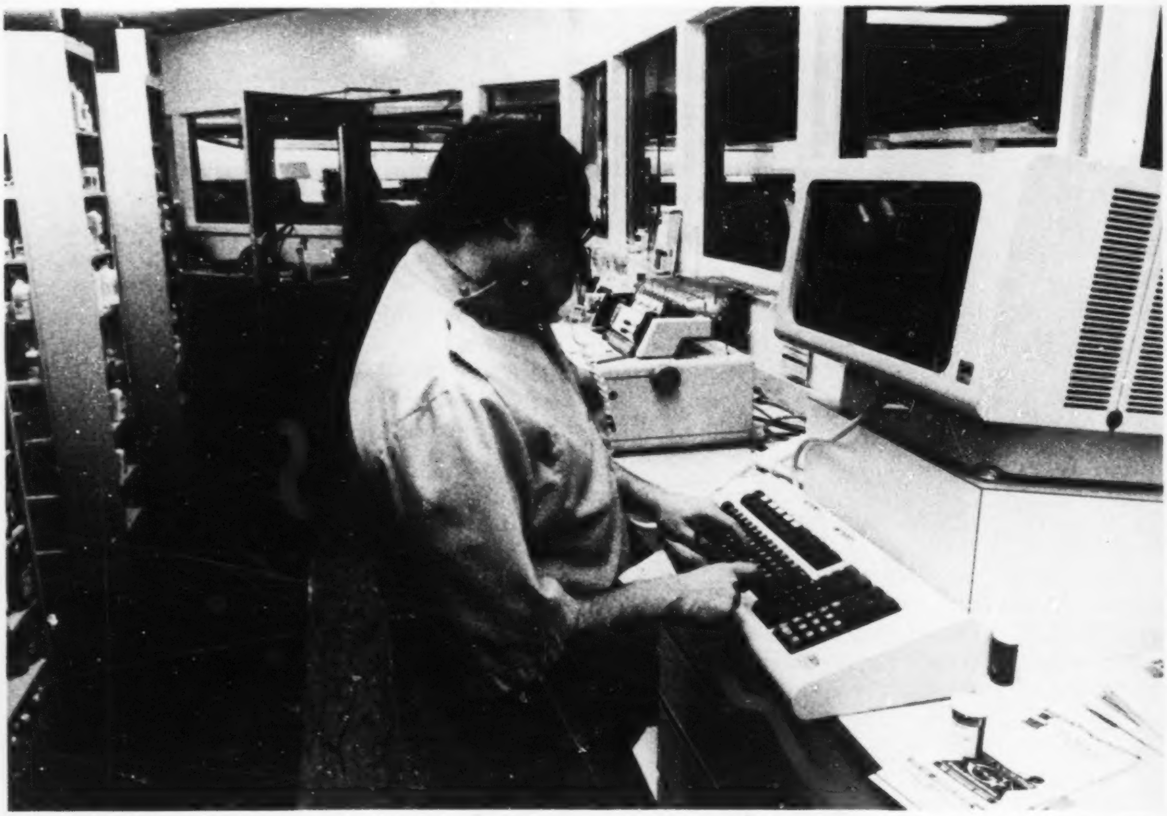

Photo credit: Giant Food, Inc.

Pharmacists use the computer to spot potentially harmful drug use that can occur when people unknowingly mix medications.

Patient compliance with drug prescriptions

Elderly patients often fail to use drugs exactly as prescribed; 59 percent of patients in a recent survey showed some "error" in drug use (54). The most common error is omission (39). The probability of error rises among women, patients who live alone, those over 75, and those who use a great number of drugs or must take drugs frequently (54). Deviance from prescription instructions is also more likely among those who have numerous diseases, who have poor vision or hearing (17), and whose socioeconomic status is low. Diminished mobility (difficulty in getting to the pharmacy to fill prescriptions) and inattention from medical care providers may also contribute to noncompliance (39).

Compliance with drug prescriptions is probably not affected by aging per se, but may be diminished by social and biological factors that become more common with age. If nothing else, the greater number of medications taken by older people increases the probability of deviating from instructions for at least one prescription.

The treatment of chronic diseases with drugs taken over long periods clearly requires persistent patient and family participation and the strong motivation of both patients and providers; these factors may not be receiving sufficient attention at present in the medical community (39). Difficulties in communication between physicians and patients may be intensified by older people's difficulty in hearing, understanding, or remembering instructions on drug use (17).

Some noncompliance is deliberate. The tremendous variation in reported rates of deliberate noncompliance ranges from 7 to 43 percent (69); one study found that 70 percent of "errors" were intentional (12). Yet the high rates of deviation from prescription instructions do not always portend ill outcomes. Compliance rates vary tremendously, depending on drug type (69), and may at times be due to a judgment of appropriate treatment by the patient. Another study showed the most common reason for not taking medications to be the *patient's* perception that he or she did not "like or need" them, which accounted for far more deliberate disuse than cost or presence of side effects (69). These two reasons accounted for 71.6 percent of patient-reported failure to follow a prescription. To the extent that patients can accurately determine their own needs for medication, such "noncompliance" may be intelligent. For example, some inappropriate prescriptions for excessive doses of hypnotic/anti-anxiety drugs, such as Valium® and Dalmane®, may be partially corrected by patients taking fewer pills than directed. Noncompliance with prescriptions, however, is not generally laudable. Misuse of drugs, whether deliberate or unintentional, can lead to serious adverse effects, and, as noted above, to preventable hospitalizations.

"Child-proof" containers may be difficult to open (15,39,41,44), and can thus cause compliance problems. New packaging for over-the-counter medications, instituted in reaction to the deliberate alteration of Tylenol® capsules, may also make opening difficult for older people. However, such protective packaging can also be a blessing in preventing accidental or poorly conceived ingestion of drugs by patients with poor mental function (41). Patients whose arthritis affects their hands are particularly likely to have difficulty opening child-proof containers, and should have easy-to-open containers ordered by their physicians.

Correct administration of drugs is especially difficult in patients afflicted with dementia and psychiatric illness, for whom expectation of patient-initiated accuracy of drug administration is a vain hope. For these patients, the involvement of other family members is essential (41). The use of medication "boxes," with drugs arranged for time of day and date by a family member or health professional can help; as can the use of charts with examples of the appropriate pill taped to the proper column. Prescription labels in lay language in large type on containers of different colored pills can also help avoid mistakes.There is great opportunity here also for technological innovation. New products relying on "smart" electronics to keep track of proper times for dispensing particular drugs are under development. One simple device in a relatively inexpensive bottle cap sounds an alarm when it is time to take the medication (Med-Tymer, Boston Medical Research, 1983). Other systems under development could dispense multiple medications on different schedules and notify patients when it is time to take a particu-

CAUTION
MedTymer
1 a-day
NOT CHILD PROOF
MedTymer
2
MedTymer
3
4

Photo credit: Boston Medical Research, Inc.

lar pill. This would be helpful to all patients requiring multiple medications, and would be particularly welcome for patients with diminished mental function (although others would have to fill the prescriptions and program the mechanisms).

Issues specific to drugs affecting mental function

DEMENTIA CAUSED BY DRUGS AND DEPRESSION

Depression may cause or complicate dementia (loss of higher mental functions) in 8 to 23 percent of patients who receive a diagnosis of irreversible dementia. This is partly due to inaccurate diagnosis, and partly to an increased prevalence of depression among demented patients (41). Further, drugs used to treat other diseases can cause dementia. Many drugs that block the effect of acetylcholine,[3] either as a primary effect or as an unwanted side effect, are used in the treatment of Parkinson disease, insomnia, hypertension (46), colds (32), depression, and psychosis (14). The rare syndrome of "atropine psychosis," a severe form of mental reaction to certain anti-cholinergic drugs characterized by psychotic symptoms, may tempt a physician to treat the psychosis with drugs that can further worsen the patient's symptoms (14). Much more common, however, is mild confusion induced by over-the-counter or prescription drugs that have mild or moderate anticholinergic actions.

Drug-induced dementia is even more common as a cause of reversible dementia than depression (25). Drugs are thus the most common cause of this syndrome, which carries the awkward title of "pseudodementia" (20). Sedatives and hypnotic drugs often diminish intellectual function in patients at all ages, and are especially likely to do so among older people.

Drugs given to correct other conditions, such as heart disease or hypertension, can also cause loss of mental functions by altering blood flow to the brain or by directly acting on brain cells. These effects are rare in younger age groups, but increase with age.

DRUGS USED FOR MANAGEMENT EASE, RATHER THAN PATIENT BENEFIT

There is some evidence that psychopharmaceuticals are used to make nursing home patients easier to manage, rather than to improve their medical condition. One study found that a small minority of physicians (1.3 percent) with large nursing home practices prescribed a large proportion (37 percent) of the anti-psychotic medications dispensed in the nursing homes sampled; the 14 percent of physicians who had 10 or more nursing home patients prescribed 81 percent of the anti-psychotic drugs (57). The prevalence of anti-psychotic drug use in this study varied widely—more than three-hundredfold—among nursing homes. Usage increased with nursing home size, and was inversely related to the ratio of nursing home staff to patient (57), suggesting that anti-psychotic medications may be used as a substitute for personnel in some institutions.

Need for increased education of health care providers

One way to improve the manner in which drugs are used is to educate the physicians who prescribe them. Such education includes not only instilling knowledge about proper use of drugs, but also increasing awareness among practitioners about the special biological and physiological characteristics of older patients. Studies suggest that physicians may base more of their prescription decisions on drug advertisements than on scientifically verified studies (3). In response to this finding, a group seeking to promote appropriate prescription habits has borrowed the techniques used by pharmaceutical companies to promote the use of their drugs—using trained personnel to personally visit physicians to educate them about common prescription errors (4). Such methods are experimental, and some have questioned the appropriateness of this approach (45), but there is wide agreement on the need to improve physicians' awareness of the importance of the vicissitudes of drug therapy among older patients.

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[3] Acetylcholine is a molecule used to communicate between nerve cells, and is implicated in memory processes. Loss of brain cells that use it is found in some diseases, such as Alzheimer disease, that lead to dementia. Blocking of acetylcholine, with drugs called anticholinergic drugs, might, therefore, lead to exacerbation of dementia and increase in confusion in susceptible patients.

Recent data show that the use of physician advisors can be especially effective in changing physicians' prescribing habits (59). A large recent study found efforts to change physician habits to be cost effective in saving funds for Medicaid. Costs of educational materials and personnel for educating physicians were $93 per physician per year, compared with $205 saved from Medicaid funds. The program was especially effective for those physicians who were the heaviest prescribers, and was received well by the physicians involved (61).

Use of over-the-counter (OTC) drugs

Many elderly people use OTC drugs: 70 percent of those 65 and over use some OTC medication regularly (64). Physicians are often unaware that their patients are taking OTC agents, either because patients do not inform them, or because they fail to ask (13). The most common drug in this class is aspirin, which is often used to treat the pain and inflammation associated with arthritis (13,35). Aspirin is one of the cheapest and most effective remedies for arthritis, but is also associated with ear and vision toxicity, loss of control of body heat, confusion, nausea, diarrhea, and gastrointestinal bleeding (13). Some patients, who also have asthma and nasal polyps, can have life-threatening reactions to aspirin. Yet aspirin is ubiquitous; more than 200 products contain it, and some of them are not clearly labeled (13).

Another common side effect of OTC medications is confusion. Many nonprescription drugs contain agents that block the effects of acetylcholine. Many nonprescription sleeping pills and anti-cold remedies contain agents that can induce confusion.

The special biological and sociological characteristics of older populations may indicate a need for caution in converting drugs from prescription to over-the-counter status. For those drugs that are used primarily by older people, special attention to the incidence of side effects in the older subpopulation may be in order when deciding to make medications available to all consumers.

Patient information on drugs

The need for active patient participation in treatment of chronic diseases requires improved methods of teaching patients about their treatments. In a recent FDA survey, 58 percent of patients received information on how to take their medication, but 75 percent received no information regarding potential side effects (48). Physicians in a recent survey believed that their patients were either very well (32 percent) or adequately (56 percent) informed about their medications (40), yet other studies show patients are often ignorant of important facts about their therapy (48). Patients rarely ask physicians about their drugs, but instead ask nurses, clerks, family, or friends (50). The transfer of information to patients is worse for older patients than for the general population, and especially poor for one group—old and less educated women (49).

Poorly informed patients are unable to make rational decisions, and may experience unnecessary drug interactions. Lack of information from health professionals leaves patients vulnerable to the advice of uninformed or ill-informed acquaintances and family members. Some of the problems in communication may stem from the reluctance of patients to ask physicians for information: in the FDA survey, only 2 percent of the patients asked their physicians about their medications (48). Heightened sensitivity to the need for adequate patient education among health providers could improve the efficacy of treatment; greater assertiveness on the part of patients could diminish anxiety and aid in the treatment process by improving patient awareness of potential adverse reactions and contraindications.

The recently formed National Council for Patient Information and Education (NCPIE) is addressing the need for increased involvement of patients in their treatment by encouraging patients to ask questions of their physicians. Current NCPIE strategy is to sponsor television and mass media advertisements (52). Other patient-information activities include community programs at the Albany College of Pharmacy, the University of Maryland, and the University of Michigan, and in Los Angeles, San Francisco, and Osceola, FL (39). Many other communities not noted in national publications are also known to have developed special patient education programs for the elderly.

Accompanying certain prescription drugs with information for patients became an area of Federal concern in 1981, when the FDA mandated the inclusion of information with prescriptions for cimetidine, clofibrate, propoxyphene, and seven other drugs. This requirement was reversed by Executive Order 12291 shortly after the start of the Reagan Administration in February 1981, although inserts are still required for several medications such as isoproterenol inhalants and contraceptives.

The delay in implementation of Executive Order 12291 coincided with the start of the voluntary American Medical Association's Patient Medication Information program, in which physicians are to distribute patient information on drugs to their patients at the physician's expense. A recent survey showed that 22 percent of physicians who prescribe medications were participating in the program; 50 percent of physicians did not know about the program, and a small minority of older male physicians disagreed with AMA policy in distributing patient-information leaflets (31).

Another program of patient education undertaken by the American Association of Retired Persons (AARP) has been especially effective. "Medication Information Leaflets for Seniors" accompany each prescription emanating from several mail prescription services available to AARP's 14 million members, who order more than 5 million prescriptions per year. The inserts, in leaflet form, explain the reason for taking the drug, how to administer it, what information the physician needs to properly prescribe it, contraindications and potential interactions with food and other drugs, and potential side effects. An early survey of recipients showed that although 24 percent of people either did not notice them or did not receive them; of those who did, 90 percent found the leaflets useful, 95 percent read them, and 76 percent kept them for possible future reference. Fears that providing patients with information about their prescription would increase anxiety were allayed by finding that 40 percent of those responding "felt better" about their medications, and 56 percent "felt no different" after receiving the leaflets (21,53). The package inserts were more extensively used for anti-hypertensive medications than for anti-arthritic agents or minor tranquilizers (51). The AARP drug leaflet is currently being comprehensively evaluated to determine its effect on patient attitudes, perceptions, and behavior (6).

Patient package inserts may be especially helpful to older patients. A large and extensive Rand Corp. study of patient package inserts sponsored by the FDA found that older patients read them more often, resulting in a small but detectable increase in patient knowledge about medications (26). Patient package inserts can thus be useful, although questions remain about patients' judgments of risk. Patients remember less about side effects than other aspects of the leaflets (26) and some patients have difficulty in accurately assessing the relative seriousness of risks (28).

Patient education need not be restricted to leaflets included with the drug. Several pharmacies have taught classes, trained educators, arranged for educational programs, or written leaflets for their older patrons. Computer networks, as noted in chapter 6, may also encourage information networks on topics related to health. National and local press also serve an important function in highlighting new developments relevant to drug use.

Congressional issues and options

Background

DRUG TESTING

The FDA's drug approval process begins with laboratory discovery of a drug's action. Once a potentially useful new chemical activity has been discovered, tests of efficacy and toxicity are performed on animals. At this point, the manufacturer applies to the FDA for certification of the New Chemical Entity (NCE) to be tested in humans as an Investigational New Drug (IND). The agent is then tested for safety in a small number of relatively healthy volunteer patients, and long-term toxicity is measured in animals. This is called Phase I testing.

If preliminary tests are successful, Phase II trials—larger clinical trials—are undertaken in a small number of patients (100 to 300) to establish dosage range and efficacy, and as a further measure of safety. Phase III is usually the final stage of testing and involves carefully controlled trials and field testing in larger numbers of patients (500 to 3,000). Although the FDA can request further testing, the agency cannot require it. Adverse effects may be detected by the clinical trials; the probability of detecting a harmful effect depends on the number of patients tested, the frequency of the reaction, and the duration of the study (67).

Elderly patients, who consume a large proportion of most types of drugs (7,38), are not specifically mandated for inclusion as patients during clinical trials performed for FDA approval. The trend in recent years has been to include more older patients in clinical trials (63), but there are no specific guidelines or regulations for assuring that clinical trials take account of the special drug needs of the older population.

There are several reasons that inclusion of greater proportions of older patients might complicate clinical trials. Volunteers and patients used in early trials must be relatively healthy to assure safety of the testing procedure. Although a more representative patient mix could be incorporated into later testing, elderly patients are likely to have several diseases, making it difficult to ascertain whether a new sign or symptom is in fact due to drug use rather than to a new disease or a new manifestation of an existing condition. And many older patients take other drugs, making it difficult to identify the particular drug that might be causing a problem. The high prevalence of disease among the elderly increases the "noise" level in drug reaction data, compounding the difficulty of detecting problems. In order to compensate for this factor, more patients must be included in tests; this pushes up development costs and makes analysis more difficult.

Problems in current methods of drug testing have been underscored by recent episodes of adverse reactions to anti-diabetic drugs, and nonsteroidal anti-inflammatory agents for treating arthritis. The problem for these agents was lack of testing in populations similar to those that used the drugs in routine practice, although this was not necessarily due specifically to a dearth of older patients in the test groups. Both classes of drugs are used more often in the elderly, however, and representatives of each of these drug classes were recently removed voluntarily from the market by their manufacturers in the United States because of newly discovered adverse effects that were not found in premarket testing. Such problems might be minimized in the future by increased attention to premarket testing in representative populations, which in many cases will involve inclusion of older individuals.

It is important to note that testing of drugs in patients over 65, if it is to be realistic, must be done in populations that have numbers and types of illnesses, average ages, and sex and racial balance similar to those groups that would actually use the drugs in practice (71).

The most difficult aspect of testing drugs in elderly populations is assuring safety. The pharmacokinetic and pharmacodynamic differences between the elderly and younger cohorts are more likely to lead to overdose than to underdose, and the increased incidence of side effects among older populations adds to this risk. Modification of current regulations regarding drug testing in the elderly could focus on issues of safety. In connection with this, the FDA has recently proposed guidelines for testing of drugs in older populations. The guidelines stress including older patients in late (Phase III) clinical trials and analyzing clinical trial data with attention to effects of aging (62). The proposed guidelines focus on the most dramatic known differences between older and younger population groups, and do not emphasize questions of bioavailability, dosage forms, or tissue sensitivity of new agents specific to older patients (67). One potential problem with establishing adequate guidelines is likely to be determination that a truly representative population of older patients has been tested (71). Identification of drug interactions is especially difficult, but also important in older patient populations because of the larger average number of agents that such patients take simultaneously. In addition, it may prove difficult to test the safety of the *long-term* drug use in older patients who often take drugs for chronic conditions over months or years. Long-term administration of drugs for older patients may expose adverse effects that appear only after cumulative use that would have been absent in tests for premarket approval. The FDA will continue to seek advice on how to establish guidelines that satisfy both public demand for safety and industrial concern over increased costs of drug development and increased regulation (63).

COSTS OF DRUG DEVELOPMENT

The cost of clinical testing is the largest single hurdle between drug discovery and routine clinical use (16). A 1978 report estimates that development of a new drug costs an average of $54 million per drug marketed, which includes the cost of testing drugs that never reach the market (22). A more recent estimate is $70 million.

The costs of new drug development vary widely, depending on the nature of the drug. Antibiotics cost less than $20 million to develop, because efficacy is easy to demonstrate, and animal models of infectious disease are readily available. Psychopharmaceuticals, in contrast, cost more than three times as much to develop—approximately $70 million each—largely because of costs of clinical testing and the absence of applicable animal models of drug action (11,19).

These high development costs have led to calls for reducing the cost of clinical trials. It is important to rationalize the conflicts between patient safety and expeditious approval. Additional costs could lead to a reduction in the rate of introduction of new and useful drugs, but loosening safety requirements might be costly in patient health and welfare. Increased drug testing in the elderly might increase the costs of clinical trials, and thus of drug development. Such cost increases could range from adding tests of pharmacokinetics in older people, as suggested by the proposed FDA guidelines, which would require only a few added tests, to extensive epidemiological surveys, pharmacodynamic studies, and tests of potential drug interactions that would cost substantially more.

Increased use of postmarketing surveillance could contribute to establishing drug safety and efficacy, and have the added benefit of focusing attention on the special problems of the elderly. Drugs could be monitored in actual use, thus identifying currently unknown adverse reactions, and adverse effects detectable by present methods might be found more quickly. Premarket test results could thus be supplemented, and premarket requirements might even be reduced in some instances; representative sampling of the elderly would be assured because monitoring would reflect actual clinical use. Safety would be encouraged by intensive surveillance. There are, however, problems with using postmarketing surveillance to assure safety; current methods of reporting adverse effects, for example, are unreliable (67). This may be crucial because safety is one of the most important reasons for the stringency of FDA clinical trial protocols. There is strong pressure to err on the side of safety, because the agency has limited power to recall drugs once they are approved (19,39,67).

Monitoring of actual drug use is an important element of drug regulation in several countries. The international nature of pharmaceutical marketing suggests that monitoring of drug use is an important area for potential international cooperation that could benefit all countries involved. Some other nations already rely more on postmarketing surveillance than does the United States. Some of this increased reliance on postmarketing surveillance is ascribed to the presence of central or national medical care delivery systems that increase physician-government contact and allow easier governmental access to patient and physician records (66). Because such mechanisms are not in place in the United States, effective postmarketing surveillance would require establishment of new means of monitoring drug effects in clinical use.

Postmarket surveillance is not, however, solely a means of reducing the need for premarket testing; postmarket surveillance is also a mechanism for assuring safety independently of premarket approval practices. There are strong arguments for retaining current procedures for premarket testing of effectiveness and safety. The stringently controlled clinical trials now required improve the quality of evidence used in making treatment decisions: new drug therapies are instituted only after careful analysis, in contrast to many other treatment modalities. Elimination or reduction of the current premarket approval process could result in proliferation of poorly verified treatments.

ISSUE 1: Should Congress require special testing of drugs in older population groups before approval for marketing?

FDA requires demonstration of safety and efficacy before approving a drug or device for marketing. At present, this does not include explicit mention of testing in older population groups. Several drugs used primarily in older populations have recently been withdrawn from the market because of concern for patient safety. Yet testing of drugs in older patients adds costs because such patients have more complicated medical histories. This complexity determines that more patients must be analyzed to assure sensitivity in demonstrating efficacy or safety.

Options:

1.1: Congress could continue present regulatory requirements.

Many believe that present mechanisms of approval of drugs and medical devices are adequate for assuring public safety.

1.2: Congress could encourage inclusion of drug testing among older populations by oversight of FDA.

This would entail obtaining assurances that interpretation of current legislation would be changed to include emphasis on the needs of the older population. The emphasis on testing drugs could be changed, for example, by requiring premarket testing of agents intended for use in those conditions identified as highly prevalent among older populations.

1.3: Congress could create new legislation to mandate drug testing among older populations.

This option would entail defining those conditions for which special testing is needed, and definition of the population to be protected.

Option 1.1 would retain the status quo for drug testing. Options 1.2 and 1.3 would be intended to protect a special population group at risk of developing adverse reactions from drugs, but would do so at increased cost to pharmaceutical and medical device manufacturers. The guidelines proposed by FDA should entail minimal increased cost (62), but more stringent requirements would increase costs further. Increased development costs might lead to fewer new agents being developed, increased risk for investors, and disincentives for established companies to manufacture such products or for companies to newly address the affected markets. Nevertheless, cost savings to other groups, including the Federal Government, might occur if the incidence of adverse side effects could be diminished. Savings would result from preventing disability and lost productivity, as well as from avoiding those health care expenditures due to adverse effects of drugs.

ISSUE 2: Should Congress require increased postmarketing surveillance of drugs already approved?

Options:

2.1: Congress could continue present patterns of postmarketing surveillance.

2.2: Congress could encourage increased use of postmarketing surveillance.

This option could include oversight of FDA activities, mandating new requirements for manufacturers and new authorities for FDA. These could be done either independently of or in combination with options discussed under drug testing.

Mandating increased use of postmarketing surveillance for drugs and medical devices could be effective in monitoring the safety of such products in actual use. This is relevant to the general population, but especially relevant to older patients, in whom the risks of adverse effects, interactions, and complications are higher. Increased use of postmarketing surveillance would entail establishing better mechanisms for reporting adverse reactions, and might require altering FDA legislation to permit FDA to withdraw drugs found to be unsafe in actual use. One potential problem in this area is access to and analysis of drug information in Federal data systems. The Computerized On-line Medicaid Pharmaceutical Analysis and Surveillance System (COMPASS) at FDA, for example, is intended to permit rapid epidemiologic surveys of drug reactions, but has been fraught with technical problems. The National Institute on Aging, with the American Association of Retired Persons and the Andrus Foundation, is supporting research on computer-assisted epidemiologic research on drug effects at Harvard Medical School (6). If Congress chooses to encourage postmarketing surveillance of drug use, more resources for epidemiologic data acquisition and information processing may be required; current university research may help determine the feasibility of monitoring for drug effects on a national scale.

Implementation of requirements for postmarketing surveillance would raise development costs for each drug and device, and thus might reduce the incentives for innovation, as also noted in the discussion of drug testing.

A more comprehensive discussion of postmarketing surveillance, which focused on the general population rather than the special needs of the older population, appeared in the OTA publication: *Postmarketing Surveillance of Prescription Drugs,* which also included specific legislative options (67).

ISSUE 3: Should Congress encourage improved patient education regarding use of medications?

Options:

3.1: Congress could refrain from taking action.

3.2: Congress could encourage FDA to issue patient package inserts on medications especially prone to misuse among older populations.

3.3: Congress could mandate inclusion of patient package inserts on medications determined to be especially prone to misuse by older patients.

3.4: Congress could encourage Department of Health and Human Services activities in the area of patient education.

This could include public service messages, research support, and development and dissemination of booklets.

Increased patient education on medications is intended to prevent misuse by providing information to consumers. It can be accomplished by voluntary mechanisms, such as those of the NCPIE, AMA, and AARP mentioned above; through executive action, as taken by the Carter Administration and revoked by the Reagan Administration; or by legislative mandate.

Those who believe that voluntary programs already under way are sufficient see no role for increased Federal intervention. Federal requirements would increase costs for those affected by such requirements. Mandating patient package inserts for medications, if supplied by the manufacturer, would increase distribution and production costs. Requiring patient education through other means, such as through physicians, pharmacists, or other health professionals, would increase the costs of their services. Increasing production and distribution costs could adversely affect incentives for innovation, as noted under other options. Increasing costs of health care would raise Federal outlays for such services. Conversely, cost savings might also be possible by preventing adverse side effects, interactions, and complications, as well as by reducing the number of hospital admissions for drug-related problems.

ISSUE 4: Should Congress encourage improved education of health care providers regarding older patients?

The special biological and social characteristics of older patients have been widely noted, yet little attention has been devoted to educating physicians and other health care providers about these characteristics (5). Increased knowledge of pharmacological differences between older and younger patients is one of many high priorities for educating health professionals about the special needs of the older population (1,24). Professional education has the potential to become one of the most effective methods of preventing future problems in drug use, and might also save some health care costs associated with drug reactions, complications, and interactions. Some educational programs directed at physicians have already been shown directly to reduce Medicaid expenditures for medications, even without taking into account the indirect savings from avoiding adverse reactions (61).

The Federal role in educating health professionals is less prominent than State and local statutes regarding certification of practitioners and proper medical practices. There is, however, a Federal role in supporting training programs for basic and clinical research and through reimbursement policies affecting delivery of health care. The problem of insufficient knowledge and education about gerontology and geriatrics is global, affecting social as well as medical fields. Actions regarding this issue are thus only discussed; congressional options are part of a larger option of general education regarding geriatrics and gerontology in chapter 2 and other chapters of this report.

ISSUE 5: Should Congress require improved labeling of over-the-counter medications?

Options:

5.1: Congress could refrain from taking action.

5.2: Congress could encourage action by FDA to require such labeling through oversight of FDA activity.

5.3: Congress could require FDA action by new legislation.

Improved labeling of over-the-counter medications, especially aspirin and drugs with mental side effects, would allow consumers to avoid agents that contain ingredients to which they know they are sensitive. Special notice of changes in drug ingredients marketed under the same name might be beneficial in some instances. Special labeling might include warnings to specific classes of individuals, such as those subject to aspirin reactions or susceptible to drug-induced dementia. It could also encompass prominent listing of potentially hazardous reactions to ingredients. Such labeling might increase manufacturing and distribution costs, increasing the price of a product needed in high quantities by several groups of patients, especially those afflicted with osteoarthritis. Potential cost increases, however, might be defrayed in part or entirely by reduced incidence of aspirin reactions and side effects resulting from unknowing ingestion of compounds that cause confusion in susceptible patients.

ISSUE 6: Should Congress authorize and fund more randomized clinical trials for drugs and treatments prevalent among older Americans?

Options:

6.1: Congress could refrain from mandating funding of more clinical trials.

6.2: Congress could direct the Health Care Financing Administration (HCFA) or the National Institutes of Health (NIH) to support more randomized clinical trials, especially for those conditions requiring multiple agents or for conditions highly prevalent in the older population.

6.3: Congress could encourage or require third-party payers (e.g., health insurers) to fund some clinical trials.

Older people are susceptible to multiple disorders, and often have conditions that can be treated in a multiplicity of ways. Treatments for such disorders as hypertension, osteoarthritis, and osteoporosis are common in the geriatric population, and yet optimal treatments for these conditions are often not apparent because of the plethora of potentially effective drugs and other treatments. Comparative studies of different treatment combinations are often not available. The large number of non-steroidal anti-inflammatory drugs, for example, have not been directly compared for relative overall efficacy, incidence of adverse side effects, and comparative appropriateness for patient subgroups. Several members of this group of drugs have not been compared with aspirin, the most common drug used for osteoarthritis. Drugs from this class have been recalled for unanticipated side effects noted in clinical use after approval for marketing, and two additional agents are currently under investigation by the Secretary of Health and Human Services. Clinical use of the different agents is a topic of current medical controversy.

The standard method for dealing with such controversies is the randomized clinical trial, the acceptance of which marks one of the major advances of modern medicine. Careful studies of different treatments can be compared under controlled circumstances to establish the utility of competing regimens, and may also determine the lack of substantial differences between different modalities of treatment (68).

Increased support for such trials, however, is likely to be quite costly. Supporting these trials from the NIH budget might detract from more basic biomedical research. Supporting trials through HCFA has been suggested, but would require a new allocation of resources within HCFA or increased overall funding for the agency. Increased support for trials could also be obtained through partial or full reimbursement by third-party payers.

Savings from such research might be obtained both for the Federal Government and third-party payers through reduced incidence of side effects due to present suboptimal levels of treatment and by preventing unnecessary complications. The magnitude of savings, however, cannot be estimated because there is insufficient knowledge about current therapeutic practices and the potential for improvement in health that might arise from rationalizing treatment.

A more complete discussion of the issues surrounding clinical trials can be found in the OTA Background Paper *The Impact of Randomized Clinical Trials on Health Policy and Medical Practice* (68).

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Chapter 6

Information Technology and the Health of an Aging Population

Contents

Page
Introduction 159
The Elderly's Ability to Use Information Technology 160
The Elderly and Self-Care 163
Information Technology for Health Purposes 164
  Computer-Assisted Health Instruction 164
  Computer-Assisted Patient-Health Professional Interactions 167
  Access to Computer-Assisted Information and Care 171
  Federal Activities 173
Research Needs 174
Conclusions 174
Congressional Issues and Options 175
Chapter 6 References 179

Chapter 6

Information Technology and the Health of an Aging Population

Introduction

The "information revolution" has profoundly affected business and commerce, recreation, education, security, and social interaction. Until very recently, this revolution has had little apparent effect on most of our health institutions and practices. Yet information technology[1] has changed the entire health system and is a distinctive element in all fields of health. These fields and contributions include:

- medical education—access to biomedical data bases;
- public health and biomedical research—computer modeling and statistical analysis;
- health care delivery—construction of diagnosis-related groups;
- patient care—access to computer-assisted diagnostic systems;
- information management—medical information systems;
- occupational health—epidemiological analyses; and
- patient education—computerized health risk appraisal instruments.

Although the rate at which information technology has been incorporated into the health care system has been less rapid than predicted 10 or 20 years ago, it is now clear that it will be an increasingly important part of this system at all levels.

Relatively little attention has been devoted to applying information technology to the specific health needs of the older population, which stands to benefit significantly from its various applications. Information technology can enhance functions diminished by the aging process in the "healthy" elderly, improve health care for those with acute and chronic medical problems, and enrich the health care services that traditional health care institutions and professionals provide. It can also disseminate information on maintaining and improving health and on the availability of services in new environments such as home and community centers.

Because there are as yet few examples of the application of information technology to the health needs of the older population, this chapter focuses on the *potential* use of information technology. The contribution of information technology to specific health fields, such as patient care and public health, can be extended to their gerontological components. Technological limitations will be overcome in time. The scarcity of current information technology specific to the elderly underscores another focus of this chapter—the *future* elderly. There are profound differences in responsiveness to any technology, including information technology, depending on age. In 10 to 20 years, the elderly are likely to have a completely different view of information technology than their counterparts have today. The difference will be even more dramatic when the "computer generation" becomes eligible for Medicare.

In this context, it is important to recognize the heterogeneity of the older population. Older Americans vary widely in such areas as financial status, health status, and levels of enthusiasm. Many older people look upon computers as another of life's opportunities and challenges (33), while others find it difficult to adapt to the lifestyle changes they can bring.

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[1] A previous OTA report has defined information technology to include "communications systems such as direct broadcast satellite, two-way interactive cable, low-power broadcasting, computers (including personal computers and the new hand-held computers), and television (including video disks and video tape cassettes)" (62). Because of space limitations and the importance of the computer as an access tool to health information, this report more narrowly defines information technology as "the application of computers and telecommunication systems to the creation, storage, manipulation, and dissemination of information."

This chapter restricts the definition of information technology to computers and telecommunications, and focuses on information technology as used by elderly individuals for their health care, either alone or, most often, in conjunction with a physician and other health professionals.

Information technology can be used both to promote preventive behaviors and to help manage chronic conditions. Discussion of its role in the health of America's elderly is important for a number of reasons. The use of information technology by the patient for health purposes has received minimal attention to date, although a large body of literature, including reviews, has looked at information technology in terms of other health fields, albeit without an age-related focus. OTA has produced two such publications, *Computer Technology in Medical Education and Assessment* (64) and *Policy Implications of Medical Information Systems* (65).

As the U.S. population ages, more people will need assistance in functioning, particularly at home. The number of elderly people confined to bed, barring unforeseen changes in disease patterns, is expected to rise from 458,000 in 1977 to 658,000 in 2000. The number of those needing help in getting around their own homes will rise from 1.9 million to 2.7 million during this period, and a similar increase is expected in numbers of those who are limited in carrying out some activities of daily living (19). Some 2.8 million elderly now need the help of someone else to carry out one or more of their daily activities (70). When adapted to the specific needs of the elderly, information technology can be a primary source of such assistance.

The growth of the elderly population will intensify demands on the U.S. health care system, producing significant increases in hospitalization, the use of hospital-based services, and nursing home care (19). By directly assisting with home health care and providing access to information concerning care for the elderly, either at home or on an ambulatory basis, information technology can reduce today's heavy reliance on high-cost institutional services.

Information technology is expected to increase the role of the elderly in their own care by improving their access to health information and services. Such technology will be used at home, in physicians' offices, clinics, or in hospitals by the elderly, either alone or with the assistance of others, including health professionals. One form of information technology, networking,[2] has the potential to greatly improve their social interaction, mental health, and access to health and other information.

This chapter discusses what is known about information technology and its use by the elderly for health purposes, including the cost of providing the technology. Two major factors underlie such use by the elderly—their ability to use information technology and the extent to which they participate in their health care.

The elderly's ability to use information technology

The ability to use information technology such as the computer varies considerably with the older individual. Those with active minds are likely to relish the acquisition of new knowledge; a computer club in Menlo Park, CA, teaches elderly members to program computers as well as to operate them (33). The Elderhostel program at Reed College, which is limited to persons over 62, offers a hands-on introduction to personal computers as one of its summer residential academic programs for older adults (49).

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[2] Networking (computer networking) is the transmission of data either to human users or to other computers through connections that link a telecommunications system. In this way, computers can transmit data throughout the Nation and the world, sharing work and data among groups of linked computers.

Even the less adventurous older person may welcome operating a computer for health purposes. The level of computer literacy needed to obtain health information need not be high, and the older individual often has assistance; in a community setting, other people are usually available to help. Home use could be facilitated by a family member, neighbor, or a paid or voluntary visitor. Difficulties with independent use of the new technologies may thus be limited to a small segment of the elderly population. Although more than 60 percent of those over 85 have major limitations in activity, this proportion is lower at younger ages. The size of this group is further reduced by the fact that with the exception of visual, neurological, and muscular problems, most of the limitations of those over 85 generally would not constrain their use of a computer terminal.

There has been little study of the ability of older individuals to use computers in general and still less about their ability to use computers for health care. Available evidence indicates that some elderly people enjoy programming and applications software, such as spreadsheets, and others enjoy recreational computer games and communicating by means of computers adapted to their capabilities.

A 1980 study of computer communication and the elderly found them highly receptive to using the computer and appreciative of the control that it afforded them. Interactive communication with other users was preferred over computer games by the subjects, who were residents of an urban retirement hotel. Their favorite game was highly interactive and simulated personal communication. The system required a number of modifications for the older users, including a large display screen and large characters on the keyboard. The presence of a trained computer demonstrator in a small group setting during the initial stages facilitated the learning process. The researchers concluded that additional modifications to the hardware, such as color-coded keys, would increase user satisfaction (18).

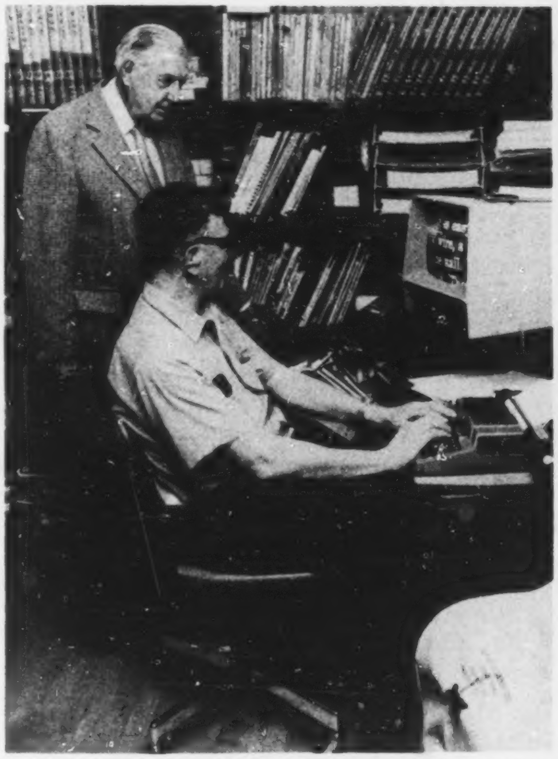

Photo credit: John F. Meehan

Computer screens with large character displays can assist vision-impaired older persons.

A more recent examination of computer use by the elderly was conducted during a series of workshops held in 1983 in Washington, DC, and surrounding suburban areas (38). A total of 200 individuals, ranging in age from 60 to 95, attended at least one of 14 workshops. The study population was recruited from educational programs for the elderly sponsored by churches, nursing homes, and recreational centers. The response was extraordinarily enthusiastic. To the surprise of the researchers, these older computer users obtained the greatest satisfaction from the programming portion of the workshop. They were apt learners and had the patience required for the task. The participants also enjoyed applications software, such as spreadsheets, but were not interested in most computer games. The study indicates that at least one segment of the elderly population—those who are active and enthusiastic—are more than ready for the computer age.

Another study found that the "frail elderly" can also benefit from information technology. A study of 50 elderly nursing home residents, whose average age was 85 and who had moderate mental and physical impairments, found that these frail elderly were able to participate in computer games that had been especially adapted for them. Adaptations included slowing down the game so that residents with such handicaps as impaired vision or hearing, tremors, or hemiplegia could enjoy winning. Most of those who were asked to participate were willing and eager to try the computer games; all were willing to try them a second time. The study points out that visual symbols in video games for the elderly must be large and well defined and auditory clues distinct and clear, and that these can be used to exercise and improve memory, enhance hand and eye coordination, and increase ability to concentrate on a task (77).

Although most of today's elderly, or, for that matter, most of today's middle-aged, have had little experience with computers, the evidence, though scant, indicates that they are receptive to using the new technology, either "as is" or when tailored to their needs. The elderly of the future are likely to be more open to using computers because of exposure to them throughout their lifetimes.

The development of new computer and communications technologies for those who are functionally limited is taking place at an astonishingly rapid pace. Computers incorporating features to counteract eyestrain or more serious vision problems are now available commercially. Oversized video displays are relatively inexpensive, but keyboards with large keys are usually custom built and costly (50). Other approaches include enlarging the letters on present keyboards or color-coding letters when only a few input commands are needed.

Display interaction—the use of light pens to obtain information from a computer—is potentially useful for elderly individuals who find it difficult to use a keyboard. The light pen, used in conjunction with a software-driven menu that appears on the screen, is pointed at the item of interest in the menu, which is then displayed on the screen. Even severely functionally limited elderly people can make contact with a computer by utilizing a sophisticated light pen that need not make physical contact with the screen in order to activate the computer. The pen is under development for those handicapped by high-level spinal cord injuries and cerebral palsy, or for amputees, among others (28).

Another substitute for a keyboard is the touch-sensitive terminal. The user simply touches a sensitized television screen's computer-generated menu to obtain audio and visual information. Hewlett-Packard is marketing a touch-sensitive system, Bell Laboratories has installed one at Epcot Center for use as an information system by visitors, and Boston's Sheraton Hotel uses one to provide information to its guests on in-hotel services and activities. Many homes are expected to have them by the mid-1980s.

Voice-activated systems that enter data and receive output on microcomputers are rapidly improving in both price and performance, with accurate representation of speech likely by the 1990s (62). Although the capability of current systems to recognize speech is limited, computers can be programmed to recognize a specific voice and follow simple commands.

Another new technique, the transparent access approach, is being used to give handicapped people access to standard hardware and software programs (73). The approach allows a specialized modular design of input and output devices for the handicapped but gives access to software and hardware designed for the general public.

The elderly and self-care

The use of information technology for health purposes by older individuals is also bounded by the extent of their involvement in their health care, either through self-care or through self-help groups. About 75 percent of all health care is estimated to be self-care (41), which substantially eases pressures on the health care system.

Self-care and self-help, as information-based health care activities, are becoming increasingly recognized as legitimate sources of care in the United States (21). Although definitions of these concepts vary, self-care can be generally defined as "actions that we as individuals perform on behalf of our own, our family's, or our neighbor's well-being" (72).

An individual's interest in being in control of his or her own health care is often considered to be the basis of self-care. This concept can be applied to all levels of health care, including care provided through the use of high technology (40). It also applies to care taken in consultation with health professionals; this application has received the greatest degree of approval from health professionals and appears to be the most appropriate for an elderly population.

Self-help groups are "clusters of persons who share a common condition, and who come together to offer one another the benefit of their experience and mutual support" (72). Broadly defined, these groups may total several hundred thousand in the United States (37). A recent inventory which used a more restrictive definition identified more than 2,000 U.S. programs offering medical self-care instruction (21).

Self-care encompasses a broad variety of activities, ranging from: 1) daily health practices, such as brushing teeth; to 2) increasing one's knowledge about health through such sources as magazines, pamphlets, and health fairs, and acting upon the information received; to 3) assuming tasks traditionally found in a health professional's realm of practice. This last mode of self-care usually requires formal training in which health skills, such as measuring blood pressure and heart rate, are learned (15).

The delegation to patients of certain tasks usually performed by professional caregivers has long been routine. Diabetics of all ages test their urine and give themselves insulin injections; persons with angina medicate themselves with nitroglycerin. Physicians and the Federal Government encourage women to undertake periodic self-examinations for breast cancer (66). Patients undergoing continuous ambulatory peritoneal dialysis are directly involved in their treatment at home (60). Health education programs, usually initiated by consumers, disseminate a wide variety of skills, such as showing parents how to obtain throat cultures from their children, and teaching women how to take a pap smear or do a pelvic exam. Computer and communications technologies are expected to play an increasingly important role in enhancing the ability of people of all ages to perform tasks traditionally done by professionals.

Although self-care and self-help programs afford wide opportunities for improving general health, many serious issues remain unresolved. These include questions on the degree of commercial involvement in the programs and the extent of professional involvement and support. Participants may feel that there is too much professional input into some programs; physicians are often concerned about the lack of a significant professional component (15). Additional issues include the political implications of certain programs, and problems of evaluating the effectiveness of any program in improving health (21).

Few self-help programs are designed specifically for the elderly, but many existing programs appear to be appropriate for their needs. An important factor in the growth of self-help groups has been the shift in disease patterns from acute to chronic illness. Chronic disease requires greater reliance on the individual, who must actively and continuously modify his or her lifestyle in order to cope with the burden imposed by the disease. Self-help groups are singularly suited to the care of chronic diseases, and many such groups (e.g., the Reach for Recovery Program of the American Cancer Society and the Cardiac Rehabilitation Group of the American Heart Association) have been established, largely as a result of private funding. Although the prevalence of chronic disease among the elderly is high, few organizations have as yet "taken cognizance of the special needs of the elderly" (15).

Self-care is also well suited to health promotion and disease prevention in terms of health risk-taking behavior. Self-care education can reduce the probability of disease, disability, or premature death from a number of illnesses in which lifestyle has been shown to play a role. The unique circumstances of the elderly make it essential that self-care education be structured to accommodate their specific requirements and expectations, yet little has been accomplished in this area.

Preliminary estimates from a large-scale effort to identify self-care and self-help programs in the United States found at least 25 self-care programs specifically focusing on training or activities for the elderly. Many other programs for the elderly include self-care as part of the curriculum. The programs vary in sponsorship and setting, target group, method of implementation, type and size of staff, and goals and activities (21). Data on the use of information technology in these programs are not yet available (20).

Futurists contend that the use of computers and telecommunications will promote a change away from specialist care to self-care (43,56). At the same time, enhanced interest by consumers in self-care and their greater awareness of health and the value of health information will be important factors in their decisions to use information technology for health purposes.

The Federal Government has played a relatively minor role in promoting self-care and self-help among the older population. The National Institute on Aging (NIA) published an excellent pamphlet on self-care and self-help for the elderly in 1980 (72), and both the National Institute of Mental Health and NIA have provided grants to train paraprofessionals to help organize self-help groups among older people.

Also NIA recently began the funding of research into the nature of older people's behaviors and attitudes (68) in using three levels of health care. The emphasis will be on self-care and informal care and their relevance to health and disease in older people, regardless of whether the behaviors have in fact been found by epidemiological studies to be "risk behaviors."

NIA has also begun accepting proposals under the Small Business Innovation Development Act for self-care research projects for the elderly. The projects are aimed at increasing the self-sufficiency and sense of well-being of older individuals by enabling them to gain confidence in their ability to prevent and manage many of their health conditions. One project would develop a blood pressure self-care modality based on systematic training and education in dietary, exercise, and relaxation techniques. Participants would be compared in their ability to control or modify their blood pressure with their counterparts in a conventional medication program (Grant Application to the Small Business Innovation Program, 8/83).

Information technology for health purposes

Computer-assisted health instruction

The use of computer-assisted health instruction is a logical extension of self-care/self-help. The growing use of information technologies for educating the public about maintaining health, and preventing or treating disease, is rapidly increasing the number of software programs on health education and management—diet, exercise, drug interactions, etc.—that can be run on a home computer (8).

The relevance of this technological phenomenon for use by and for the elderly has not yet been widely recognized in either the private or public sector, however. The use of information technologies, particularly the microcomputer, could help the elderly maintain independent living, and is likely to be particularly effective when used in conjunction with physicians and other health care providers.

Current efforts to develop such technology specifically for use by the elderly are hampered by lack of interest and lack of funding, but a few projects are underway. A specialty group associated with the American Association of Medical Systems and Informatics, for example, has a specific interest in health assessment of the elderly and automated systems for this age group. Their focus is on information systems support for older Americans, with an emphasis on health promotion and disease prevention, and on developing a computer-assisted personal health management system for promoting the concept of wellness of the elderly (12).

Although very little computer-assisted software health instruction material is being developed specifically for the older population, health software is being produced by all sectors, including the for-profit, not-for-profit, not-for-profit with for-profit sponsorship, and by firms or academic institutions with a wide variety of expertise. A relatively large number of such products has been developed for mainframe computers, and the number of such programs for microcomputers is beginning to grow. The rapid expansion of personal computer capabilities has catalyzed the development of software packages to the extent that the Office of Disease Prevention and Health Promotion of the Public Health Service publishes a list of health promotion software for health educators, other health professionals, and individuals interested in developing good health habits. Topics include basic living skills, general health information, health risk appraisals, stress management, and nutrition and diet (70). Most of the software programs, which are not evaluated, are marketed by for-profit firms and few are inexpensive. The issue of costs and individual application of information technology, including software, is discussed later in this chapter.[3]

As in any new product area, problems abound. The field is diverse and unsettled. In some cases, programs are developed by transient "entrepreneurs" who lack subject knowledge and are often forced out of the market. A large number of colleges and universities have developed health instruction materials and are marketing or planning to market their products. Most available software programs have not been evaluated, but the serious issue of establishing evaluation criteria is beginning to be addressed (32).

TYPES OF INSTRUCTIONAL PRODUCTS, DEVELOPERS, PRODUCERS, AND SETTINGS

Private sector health software programs vary widely in both content and price—from nutritional programs that cost as much as $700 (69) to weight control and nutrition programs that help users balance meals and create weekly menus for $39.95 (55). Diabetics, for example, can purchase $100 software programs that focus on their daily fluctuations of blood sugar and insulin.

In the nonprofit sector, the Kellogg Foundation is funding the development of health education and promotion software for use by adolescents and their families, primarily in clinic settings. Topics include alcohol and drug abuse, stress management, smoking, diet and exercise, human sexuality, and family communications (10). The program is being systematically developed, tested with control groups, and evaluated; a preliminary report on its effect on the health knowledge, attitudes, and behaviors of adolescents is scheduled for early 1985.

Manufacturers of the Apple computer have sponsored the development of a number of health information programs at Ohio State University. When one such program, "Kardia," which describes risk factors for heart attack, was assessed by patients in the waiting room of a family practice clinic, 95 percent found it acceptable. Patients had to access the program and interact with the material presented; 91 percent said that it was both helpful in providing an understanding of health and very easy to use (17).

A software package developed at the Abbott Northwestern/Sister Kenny Institute, in cooperation with a firm with expertise in microcomputer courseware technology and educational methodology, illustrates how information technology can be adapted to the needs of a particular population, in this case hospital patients with low back pain. The Institute is a major medical center that is both an acute care facility and a rehabilitation center; a considerable proportion of its patients suffer acute and chronic low back pain. The software takes the physical status, learning readiness, and motivation of the patient, and the resources of the health care facility into account. The microcomputer is accessible to patients at all hours, so that patients can use it when they are not in pain, and is portable so that the keyboard can be used easily from a wheelchair or at bedside. Segments of the course are short to accommodate to the patient's comfort level and attention span. Upon leaving the hospital, the patient better understands the problem and has received instruction for lifestyle adaptations to protect himself from further injury. The courseware is currently being marketed through the Institute and a computer consulting firm (16).

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[3] A computer monthly has also published an article listing a number of commercially available nutrition, diet, and fitness software programs (23).

A computer-based education program for patients with rheumatoid arthritis, written at the University of Connecticut School of Medicine, is one of the few programs that has an evaluation component (78). The program's initial evaluation found that participants demonstrated more positive changes in knowledge, self-reported compliance behaviors, and affect than did a control group. The interactive program is stored on a mainframe computer located at the university's health center, where it can be accessed by telephone from terminals located at any site, and is written in lesson format. Although the program was not developed for the elderly, it does make some provisions for them. A planned software program on osteoarthritis will have several access features for older patients, such as a large-type option, a cutout template that is blocked off and color coded for different functions, and, possibly, a speech synthesizer (57).

The use of computers for in-hospital health education appears ready for major expansion. The American Telephone & Telegraph Co. (AT&T) is exploring the potential for developing computerized health educational materials with Johns Hopkins Hospital and other facilities. Little detailed information is yet available about the project, which is in the planning stage, but it may utilize video disks, and a software program instructing patients in post-heart attack management may be developed (51).

Software packages for health hazard/health risk appraisals (HHA/HRA) are also proliferating. The HHA/HRA is a technique for health promotion in which the user fills out a questionnaire and then receives information on his or her health status and recommendations for change. The appraisal rates the user's chances of becoming ill or dying from selected diseases by comparing self-described health-related behaviors and personal characteristics to mortality statistics and epidemiological data (74). The appraisal is designed to motivate individuals to change their lifestyle and improve their health (22), but because it generates a statement of probability and not a diagnosis, it can present problems (26). Many consumers lack the expertise needed to distinguish between risk factors and diagnosis and may not understand the information they receive. Thus some researchers contend that computer-assisted appraisals are best when part of a comprehensive program that might include face-to-face interaction with health professionals and written explanatory materials (47).

Few HHA/HRAs have been developed for the elderly population, although a number of instruments are available to health professionals for use in assessing the general functioning of their elderly patients (36,42). Numerous self-administered scales have been developed to measure psychological conditions in the aged (36), and computer games could be devised to measure various aspects of aging, such as cognition (35).

Because many database and methodological problems are associated with the construction of health risk appraisals, their use is controversial (74). Even when coupled with programs known to decrease the prevalence of risk indicators, it is not known whether appraisals will in fact yield dividends of healthier, more productive people and reduced expenditures related to illness, disability, and premature death (26). As is the case with many health care technologies now in use, their role and value have yet to be fully evaluated.

There are also unique problems associated with using health risk appraisal instruments for today's elderly. Most consider health care as care to be taken after an illness or injury has developed. They have been given little education regarding the advantages of preventive measures in delaying illness and maintaining health, and are unaware of the effects of diet, exercise, and environmental factors on health status (12). Efforts to provide information to the elderly on improving health habits are thus apt to meet with limited success. The elderly of the future are likely to be far more sophisticated about both computerization, as has been noted, and about health maintenance and prevention. One researcher has found that "most individuals—independent of background, income, or education—are fascinated by computerized health risk appraisal" (22); he does not, however, mention age as a factor.

A few efforts are being made to adapt computer-assisted health risk appraisal/assessment instruments, such as the CDC Health Risk Appraisal instrument "Lifechec," for use in programs of health education and health promotion for the elderly. One such effort was made by the Rhode Island Department of Health as part of its Wellness Check program, which utilized a computer housed in a mobile unit that traveled to all areas of the state on a request basis. People were approached by health educators and asked if they were interested in answering questions about their health. Most of the contacts were made in shopping centers. The HRA was deemed a success with adolescents and most adults, but after a trial period, attempts to adapt it to the needs of the elderly were abandoned when those who were contacted showed little interest in health appraisals and did not cooperate well with the program. The study's criterion for assessing success was interest on the part of the users in doing the appraisal. For the most part, the elderly approached had little education and were in a low socioeconomic group. Although there were no specific data to explain the level of disinterest in this particular case, researchers noted that adaptation of this type of instrument must take account of the nature of the target population and their capabilities (36).

Photo credit: Mary Bader, from Kearsley and Furlong, "Computers for Kids Over 60," 1984

Older persons are generally receptive to the use of personal computers.

The Office of Geriatrics/Gerontology at Ohio State University is working on a prototype for a Computer-Assisted Personal Health Management System for the Elderly that would include active patient/client participation in self- and peer-health management. Participants will be volunteers from an existing program at the university that offers courses free to all Ohio residents 60 and over. The Lifechec health risk appraisal instrument is being modified for use by this elderly population, which is ambulatory and healthy; the health risk appraisal is not a tool for the frail elderly. The initial phase will have the users complete a standard form, which will then be "uploaded" to the university's mainframe computer for analysis. In time, the researchers hope to have the users enter information directly with a hand-held keypunch instrument. The individual's printout will be reviewed by an interdisciplinary team and then interpreted for the participant. Specialized teams will consult with participants in areas such as exercise and nutrition, and programs will be designed to meet their individual needs (12).

Computer-assisted patient-health professional interactions

Future computer use by patients is expected to reach beyond providing them with information about their health status to become a virtual "hospital on the wrist" (9). The concept of the hospital on the wrist includes a computer, a microminiature analyzer, and drug reservoirs with electronic probes capable of monitoring changes in the body, measuring vital signs, analyzing blood and enzymes, and comparing findings with expected values for the individual wearing it. The device would be able to communicate with computers of the wearer's physician as well as with computers in hospitals or other medical institutions and could administer drugs directly through the skin. It could also signal the patient when direct medical care was needed.

As envisioned, the hospital on the wrist does not offer the patient total medical autonomy but includes interactions between the patient, his or her computer, and the computers of health professionals. Computers and telecommunications now in use by patients for health purposes are oriented to assisting physicians and other health professionals with patient management in various health settings.

Although not developed specifically for older age groups, there are numerous health care uses of information technologies of potential benefit to both the active elderly and the dependent or frail elderly.

A longstanding application of the technology has been in taking medical histories from the patient in a hospital setting. Computer interviewing and assessment have been used for taking various types of medical histories, including general medical histories (53), and thyroid histories (29). The technique has also been used with the elderly, employing a small digital computer, cathode-ray screen, and typewriter on which the patient responds to questions that appear on the screen (25).

In a system now in use at the Beth Israel Hospital ambulatory care center in Boston, a computer reviews all of a patient's body systems and asks questions about past medical history, habits, family history, and social history. Using branching logic, the computer interacts with the patient.

Drug use by the elderly poses a particularly serious problem for their health. (See *Chapter 5: Medications and the Elderly*.) Community pharmacists can actively aid older individuals—today's as well as tomorrow's—by means of the "smart card," a magnetic-stripe plastic card currently used by merchants to verify a cardholder's credit status and by banks for cash-giving machines. The new smart card contains a microprocessor and memory chip. Since the smart card has the ability to keep a journal of transactions, an individual could have all his prescription drugs encoded on his card by the pharmacist. Each card is programmable, to help assure safety and confidentiality. The pharmacist could periodically review the individual's prescriptions and monitor for any number of potential problems, such as drug interactions.

A computerized prescription system now in place in a large supermarket/pharmacy chain in the metropolitan Washington area uses an extensive database of drug and personal information to retrieve information on file whenever a customer has a prescription filled and to alert the pharmacist to possible problems, such as drug interactions or harmful effects of a particular drug on allergies or medical conditions. (Patients may be seeing several doctors, who inadvertently write conflicting prescriptions) (75).

Computers can also be used at home to assist with care of the elderly. The use of home computers to assist the health professional has been suggested for incorporation into the clinical practice of mental health (1). Although many interactive, self-help, mental health programs are not considered to be scientifically based, quality programs might be developed by techniques of artificial intelligence. For example, some aspects of the Kellogg Foundation-funded program discussed earlier are being adapted for home use by adolescents and their parents. Patients of family therapists and counselors currently use interactive computer programs for personality assessment and mental health diagnosis and treatment programs in physician's offices. Some may be suited for use in the home.

Computer-assisted mental health programs for home use have both positive and negative implications for the mental health profession and its clients. Mental health software programs may free professionals to concentrate on their most difficult and challenging problems (27), but their extensive use might also limit the careers of young mental health professionals (24). Although it is believed that certain areas, such as stress management, may be as effectively managed by computer instruction as by a therapist (1), there is also concern that some programs may simply delay recovery in some cases (76).

The elderly, particularly the home-bound elderly, could profit from the availability and accessibility of computer-assisted mental health instruction. Home computer use could greatly enhance their ability to obtain reliable assistance with psychological problems and anxieties that are often overlooked and untreated. Effective computer-assisted instruction in the mental health field, as in all health fields, will require the guidance of professionals in the development, use, and evaluation of self-help programs.

Information technology can also assist health professionals with the care of the *dependent* elderly, who are a minority of the over-65 population, yet use a disproportionate amount of this age group's health services. Frail individuals would benefit from the availability of personal health software that combines diet, exercise, and stress monitoring. They could establish their own biochemical profiles to determine efficacy and safety of particular drugs for themselves (9), and develop diets appropriate for their health maintenance.

Some members of the older population have multiple chronic health problems that require extensive care and treatment (70). Some 77 percent of the elderly have annual Medicare reimbursements of less than $500, but 8.8 percent have average Medicare payments of more than $3,000 .(7).

Computer-assisted health care that complements professional care may enable chronically ill people to remain in their homes when they wish to do so. About 45 percent of the noninstitutionalized elderly presently face limitations caused by chronic disease. Although this *proportion* is not likely to change dramatically, the total *number* of those limited by chronic disease is projected to rise sharply as the over-65 population grows from 27 million in 1983 to 35 million in 2000. The oldest group of elderly—those over 75, who need the most care—is growing even more rapidly. In 1965, 37 percent of Medicare's elderly enrollees were over 75; by 1981, this proportion had risen to 41 percent (58).

A number of factors point to an increase in the proportion of the chronically ill population who may choose home care over institutional care in the future. An estimated 15 to 20 percent of today's institutionalized elderly could be living at home if home health services were available and reimbursable. Such services are gradually becoming reimbursable through a number of funding sources, such as Title XX of the Social Security Act and Title III of the Older Americans Act. Services are also becoming available as a result of the phenomenal growth in segments of the home health care industry. According to the National Homecaring Council, the number of homemaker/ home health aide service programs has grown from 300 in 1972 to more than 5,000 in 1984 (45).

Moreover, advances in medical technology now allow services to be provided at home that once required an institutional setting (2). Reductions in size and complexity have made many machines portable. By the late 1980s, consumers are expected to spend at least half a billion dollars annually for electronic devices to be used in the home for health monitoring and disease prevention (9). Use of these devices will be limited, however, by the need for accurate diagnosis of illness, which requires training and knowledge to interpret the results of the instrumentation (46). Telecommunication equipment connecting patients and health professionals will facilitate their interaction and enhance the quality of care.

Increases in the supply of U.S. physicians may counteract the need for computer-assisted professional care, since one reason for such care is physicians' disinterest in making house calls. Government estimates indicate an aggregate surplus of physicians by 1990 that will persist into the 21st century (71). Nonetheless, the specific services needed for the homebound elderly may not be available. These projections also point to a shortage of general psychiatrists by 1990 and a near balance in the numbers of family practitioners and osteopathic general practitioners at that time. But the projections did not analyze geriatrics, nor did they account for geographic variation in physician-population ratios. Thus, a surfeit of physicians would not ensure adequate numbers to meet the special needs of either the elderly in general or the homebound elderly in particular.

Among the health information surveys now available at home is "CompuServe," which gives subscribers access to a medical "bulletin board" that includes listings of health professionals, and affords physicians an opportunity to exchange information. Future applications of such technologies to the needs of specific patients, particularly homebound patients, are likely to be extensive. Instructions on patient care can be programmed for use in the home by the patient or a family member when needed, which may enable home health agencies to reduce the number of home visits by nurses and other health professionals. One exciting application would redefine the term "house call" by connecting homebound patients with physicians' offices; physicians and other health professionals would then be able to make electronic house calls.

Few of these efforts have been directed at the needs of the elderly, but research in such fields as rehabilitative medicine provides insight into the potential for using information technology to give older individuals special care. Adapting technologies for the elderly can be extremely difficult because this population is so heterogeneous, and because the introduction of a technology into their lives must often be accompanied by an educational effort to convince the patient of its utility.

An interactive system of medical monitoring between the patient's home and the professional's office can be designed in a variety of ways. For example, the computer periodically calls patients and prints out routine questions. If the response is abnormal, unusually slow, or not given, the computer notifies the appropriate health professional. In a similar system, "Lifeline," which is now operational, the patient wears a lightweight transmitter that is electronically linked to a health care institution 24 hours a day. To call for help, the user presses a button on the transmitter, sending an electronic signal to the health care institution's computer. The computer identifies the user, notes the time of the signal, and personnel monitoring the system use the information stored in the computer to determine if help is needed. The system automatically sends a signal to the computer if it is not reset twice each day.

Other examples of medical technologies that can be connected to computers, thereby assisting health professionals with patient care, include analog signals from both mechanical and electrical devices that can be converted to digital signals for transmission to health professional computers. If desired, the health professional can transmit information back to the patient or directly to the device. Future medical technologies may operate digitally as do products currently in use, such as watches and bathroom scales, thereby eliminating the need for conversion of signals from analog to digital systems.

"Smart" sensors—those incorporating microprocessors—currently sense and measure blood pressure, pulse rates, body temperature, and electrical activity of the heart. Measurements of other physical functions have been developed for use in rehabilitating handicapped patients; those that have the potential for computer-based processing may be applicable for monitoring the health status of segments of the older population. For example, a patient with a spinal cord injury who has returned home from the hospital can be monitored for the number of times and length of time he or she is out of bed by means of a pressure-sensitive ribbon switch located under the mattress and a strip chart recorder (30). A protocol for computer-based monitoring of such chronic problems has been developed that would enable a physician to monitor the patient's movements (54). Periodic measurements of the movements of a partially bed-bound elderly patient would assist a physician in evaluating the patient's progress.

Computer technology can enable hospital-based approaches for managing chronic diseases to be expanded to the home. A study of cirrhotic ambulatory patients found that they were able to systematically measure and communicate medically and behaviorally significant information (54). A health aide telephoned the data to a laboratory, where they were entered into a computer terminal and analyzed. The method can be used with many chronically diseased patients, and helps involve them in assessing—and potentially managing—their chronic diseases. When adapted for direct linkage to a computer and utilized for an elderly population, the rapid processing of data provided by ambulatory patients from their homes can promote continuity of care approaching that provided in hospitals.

Various computer and communication technologies can be used within the home setting for health purposes without involving consultation with health professionals. Computers that monitor such household functions as turning lights, radios, and televisions off and on, and provide wake-up service by voice synthesizers that speak pre-programmed messages (52) could be programmed to remind elderly persons of medication times, instruct them on diet and medical care practices, and remind them of physician and other health professional visits. Devices could be programmed to track medicinal intake and periodically dispense medicines. A bedside automated programmable dispensing machine has been developed for use in hospitals (5) that may be adaptable for use in the home (6).

Access to computer-assisted information and care

Information technology is expected to enhance the independence of the older population, including the home-bound elderly, but the extent to which older individuals will have access to computer-assisted information and care is conjectural. For example, their current level of access to the type of information technology known as intersite networking is not known at present. In intersite networking, a home or office terminal and modem are connected to a mainframe by means of a telephone or cable; the "Lifeline" system and arthritis self-care program are two examples. AT&T has conducted preliminary experiments in providing health information in a home setting by networking homes to regional mainframes, but as is traditional in the private sector, information is proprietary and the company has released only scanty information on the developmental process.

The number of elderly who have access to terminals or microcomputers in the home is not known, essentially because the age of individuals owning or having access to personal computers has not been determined. Estimates of the projected penetration of U.S. homes by computers vary widely. A 1983 study estimates that approximately one-fourth of U.S. households will have personal computers by the late 1980s, and a 1979 study by the University of California estimates that at least half of the projected 97 million households in the United States will have them by the end of the decade (8). A third study expects this proportion to exceed two-thirds (8,39). OTA has calculated that by 1986 there will be almost 5 million personal computers used in the home (62). Estimates of the current number of home computers in households also vary substantially. The Wall Street Journal estimates the number as 4.2 million, the InfoCorp at 5.5 million, and Future Computing and the Yankee Group, market research firms, estimate the number as approximately 7.5 million (39).

Photo credit: Lifeline Systems, Inc., Watertown, MA

One type of home-based alarm system is directly linked with a central computer.

Although prices for home computers have declined steadily, a major constraint to their access by the older population may be cost. A 1982 report on prices of personal computers found a range from several hundred to several thousand dollars (62). Hand-held computers sold for a few hundred dollars. Although they are deficient in a number of characteristics, such as size of display area, hand-held computers could be designed to connect with other hardware devices and to be linked over a phone line to a larger system in a physician's office, clinic, or community organization.

Prices for personal computers of similar capability are continuing to fall. It is currently possible to purchase a Commodore 64 with a disk drive at a discount store for about $400, which is less than the price of most color television sets. A "Home Teller" program initiated by the Madison National Bank in Washington, DC, offers an installment purchase plan for the Commodore 64; by maintaining a $1,000 interest-free balance and paying $15 a month, a customer can access his or her banking information and own the computer in 36 months. The Chemical Bank in New York and California's Bank of America offer similar plans (4). As soon as the bank customer receives the computer, it can be used for other purposes, including health purposes.

There is little consensus on future computer prices. Software programs for personal computers continue to improve and their prices to decline, but whether this trend will continue is unclear. Perhaps the greatest unknown at this time is the future price of telecommunication services. The price effects of the breakup of AT&T have yet to be determined.

Whatever the future costs of computers, software, and telecommunication services, some members of the elderly population will not find them affordable or attractive, even for health purposes. Although income levels vary widely among those over 65, the elderly tend to be concentrated at the lower end of the income distribution, as shown in table E-11 in appendix E. Nonetheless, income, as but one measurement of monetary assets, does not indicate total financial worth. Both savings and committed expenditures will influence the purchase of information technology. Many members of the older population own their own homes and have either paid off their mortgages or are doing so at low interest rates. Their health expenditures, however, are higher than those of any other age group.

Many members of the elderly population will have access to software programs in libraries or community settings, and those who are still employed are likely to find computers in the workplace. Current estimates by International Data Corp. establish the ratio of computer terminals to office workers at 1:5; by the end of the next decade the ratio is expected to be 1:2.

A major obstacle to accessing computer-assisted instruction and care is the incompatibility of equipment. Software programs are usually written for specific microcomputers. The fact that they cannot be transferred between different machines, a problem for users of all ages, is particularly acute for those over 65 because of the scarcity of programs for their use.

Older individuals who have functional limitations have additional access problems in that they often find it difficult to use computers designed for the general public. More than 11 million visually impaired Americans of all ages (most are over 55) find it difficult or impossible to read information on conventional display screens (3). About half of all Americans who have hearing loss in one or both ears are over 55 and are often unable to understand spoken messages on the terminal or from a computer terminal; many cannot hear the "beeps" some computer programs produce. Many older individuals whose mobility is restricted also find it difficult to reach the equipment or have trouble with keyboard control.

Awareness of the need for special equipment for the handicapped has risen significantly in recent years (73). For the most part, specialized equipment to enable handicapped individuals of all ages to use information technology has not been produced by mass market manufacturers because the demand for such technology has been difficult to demonstrate. Available demographics do not delineate the true number of elderly individuals with specialized needs because older people with functional limitations are not accurately represented in the census or other surveys. Many of those who have limitations cannot respond to surveys because of their limitations—e.g., deafness. Of greater importance is the complexity of payment arrangements for adaptive computer technologies. In almost all cases they have not been considered health devices by Medicare and Medicaid. The availability of appropriate private insurance coverage depends on a number of factors, including employment and State laws.

Until now, specialized equipment has been manufactured by "thin" market manufacturers or has been custom-made, and is not inexpensive (11). Advances in the field are so rapid, however, that it is impossible to forecast the size and configuration of the market in even the very near term. For example, only one company manufactured key guards in January 1984. By April 1984, there were seven brands of key guards on the market.

Significant developments in alleviating some of the problems of the functionally disabled are the improvements in standardizing the connections between adaptive devices and commercially available computers and in providing access to standard software programs for those using assistive devices.

Whether it is Government's role to intervene on behalf of those older persons who would benefit from the accessibility to health services that computer and telecommunication services would afford is a matter of resource allocation.[4] At this time of Federal financial constraints, Federal resources are not sufficient to provide all technologies to all people who need them. Money that is applied in one area of technology limits that available for other areas. Conversely, it is appropriate for the Government to assist with providing goods and services that the private sector cannot. Important considerations in making decisions concerning information technology for the aged include:

1. the degree to which encouraging independent living for the elderly is a priority of Federal resource allocation policy,
2. the cost effectiveness of information technology, and
3. the extent to which information technology will encourage independent living for the elderly.

Federal activities

The level of Federal involvement with information technology and the aged has been minimal. The National Institute on Aging (NIA) of the National Institutes of Health (NIH) has sponsored the development of information systems in nursing homes in its teaching nursing home program. OTA has been able to identify several projects that the Federal Government may sponsor that directly address the use of information technology by the elderly for health purposes. One project, still in the planning stage, will investigate the use of microcomputers and computer games to improve elderly people's mental and social interaction. It may be submitted to NIA under the Small Business Innovation Development Act (Public Law 97-219). Under the same program, the NIA has received a number of proposals for automatic drug dispensing systems that utilize computer technology.

The use of information technology would be appropriate for other programs for the elderly now under consideration. In planning for a national health promotion campaign for the aged, the Office of Disease Prevention and Health Promotion of the U.S Public Health Service and the Administration on Aging are sponsoring a project aimed at identifying effective ways to communicate health information, particularly on nutrition and fitness, to older people, emphasizing actions that promote health and prevent disease. A current NIA grant and contract solicitation calls for grant applications for research projects designed to identify specific modifications of the social environment, including the home, that may improve the health of middle-aged and older persons (67). Listed as a possible area of investigation is research on technological changes that can be introduced into homes to maintain independent living for frail, older people. In addition, a special grant announcement soliciting proposals to demonstrate and evaluate the impact of covering prevention services in the Medicare program was published in the Federal Register on August 12, 1983. The announcement calls for studies of Medicare reimbursement for a package of prevention services, including health education/promotion services.

The Federal Government has been involved in other fields that have relevance to information technology for the elderly. For example, the Government has played a role in the research, development, and diffusion of information technologies for the handicapped (63). As has been noted, information technology developed for the handicapped can in many cases be used by the elderly.

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[4] A recent OTA report provides a comprehensive view of the Government's role in technology for the handicapped (63).

The Federal Government has also played a part in information technology for education in general and for special education (62). Some of the information technology developed to instruct retarded children, such as memory aids, could be adapted for use by the elderly.

Research needs

To make the most effective use of information technologies (computers and communications technology) for the elderly requires investigating areas that range from the physical sciences to the social sciences. Current research needs include:

- The effectiveness of self-care/self-help, health education and the specific techniques of HHA/HRA, and home care in promoting and maintaining health and monitoring health care among the elderly. Computer-assisted programs in these areas need special attention with respect to both development and evaluation.
- The economic implications of self-care and self-help.
- The ability of various subgroups (by age, by general health status, and by disability) within the elderly population to use computer and telecommunications technology.
- The development of new and adaptation of current computer and telecommunications technology to the needs of particular subgroups of the older population, according to age, general health status, and disability.
- Methods of involving the elderly in the development and delivery of information technology.
- Methods of encouraging the development and transfer of current and future computer and communications technology to the older population. Of particular importance are proper interactions between the public and private sector to ensure equitable access of elderly persons to information technology, especially those with functional limitations.
- Methods of reducing financial barriers (within reasonable restraints) to the acquisition of appropriate information technology by the older population.
- The application of artificial intelligence to interactive computer programs.
- The evaluation of software programs for safety, effectiveness, and instructional strategy (discussed further in the *Congressional Issues and Options* section at the end of this chapter).

Conclusions

A major consideration in formulating policies regarding information technology to be used by an elderly population is matching technologies to users. "Appropriate technology"[5] is a clear need in many cases. Also important are the reactions of society and its institutions to existing and future technological capabilities and its willingness to assume financial responsibility for diffusion of various technologies.

As has been stressed throughout this chapter, society has thus far placed little emphasis on the research and development of information technologies specifically for use by the elderly, either alone or in conjunction with health professionals. The preceding list of research needs testifies to the absence of rigorous information. Interest in this area, which has been lacking in the field of information science, is now beginning to surface. Professionals who work with the elderly have begun to realize the assistance that information technology can afford their clientele. Awareness of the potential of information technology in assisting with the health of the elderly population, and cooperation among information scientists, gerontologists, and other pertinent specialists are both very much in their infancy.

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[5] In a previous report, OTA used the term "appropriate technology" to refer to technology that is developed or adapted in response to the needs, desires, and capabilities of disabled people and applied appropriately. The same concept of appropriate technology is used here to refer to appropriate technology for elderly people. It is also recognized, however, that the elderly are an extremely diverse group that includes many older individuals for whom there may be no need to adapt the technology used for the general public (63).

The information technology that is available has been developed for other populations, such as the general public, the business community, health care organizations, or the handicapped. Much of it can be adapted to fit the needs, desires, and capabilities of the elderly. Although it is sparse, there is convincing evidence that older people can benefit from using computers. Indeed, many of today's older individuals are completely comfortable with the new technology. The elderly of the future will find computers much "friendlier," in both a technological and a social sense.

Information technology can be used by those over 65 for health purposes in two major ways. One is computer-assisted health instruction. The use of computer-assisted health instruction for the population in general is new, and scant attention has been paid to developing programs for specific populations, such as the elderly. Although the market is growing, the number of software programs currently available is very small, and few have been evaluated. The market is complex in terms of the vendors of such programs. Some programs are developed and distributed by for-profit firms whose substantive knowledge of the subject matter or ability to produce a quality product may be questionable. Other programs are being developed under the aegis of university programs and subsequently marketed. A minute proportion of such programs specifically address the needs of those over 65.

Information technology can also be used to assist health professionals in monitoring the care of older adults. Many available and emerging technologies can be adapted for interactive use by the elderly and health professionals. Yet there remains too little recognition of this potential use, either by manufacturers of the equipment or by their distributors.

Society is on the verge of applying concepts developed in other areas to the needs of the elderly. The time is thus propitious for developing policies that will make a significant contribution to the research, development, and diffusion of information technology appropriate for use by and for older individuals. The appropriate utilization of information technology by the elderly is not, however, inevitable. A key consideration in formulating policies regarding information technology to be used by those over 65 is society's commitment to the use of present and future technological capabilities. Although it is an avowed goal of Federal policy to keep the elderly out of institutions and promote their independence, there are substantial costs involved in the research, development, and diffusion of information technology for the older U.S. population. These costs need to be evaluated against "helping the senior members of society continue as viable participants in its processes" (48).

Congressional issues and options

ISSUE 1: Should Congress assume major responsibility for assuring the quality of computer-assisted health instruction for the elderly?

These policy options are intended to assure the quality of computer-assisted health instruction for the older population. Most of the alternatives do not require new legislation because sufficient authority has already been written into law. Rather, desired actions could be stimulated by congressional interest or oversight.

The principal question to be addressed is the extent to which the Federal Government should be involved in activities concerning the quality of computer-assisted health instruction for the elderly. The use of the technology for all age groups, and particularly the older population, is in a very early stage of development. It is not yet a viable means of promoting, maintaining, or monitoring the health of the older population. But beneficial health-related software programs for this population can be forthcoming if adequately fostered. Because of the possible physical and financial vulnerability of those over 65, the quality and credibility of the content of health-related software programs for this age group require attention.

The Government's role could depend on the types of computer-assisted health programs for the elderly, which vary along a number of parameters. Of particular relevance for the quality issue are the specificity and uniqueness of a program's content. Quality and accuracy of information are necessary to all computer-assisted health education, including general instructions on broad subjects, such as good health habits, the nutritional value of foods, and HHAs/HRAs. Quality assumes still greater significance in software programs that instruct individuals on managing specific health conditions with counseling, drugs, or medical devices. Quality is also an essential component of an individualized software program that instructs a person on the care of his or her particular medical problem. Because, however, such programs usually require continuous consultations with and revisions by a health professional, some aspects of quality control are informally in place.

Options:

1.1: The private sector could assume responsibility for the quality of the content of health instructional software for the elderly.

Although computer-assisted health instruction is not a new technology, there is as yet no formal mechanism in the private sector to oversee the safety and effectiveness of the content of software programs. Computer-assisted health instruction has been used for a number of years for the education of health professionals. In the early 1970s a number of software programs for the general public appeared on the market, but most were of poor quality and did not achieve commercial success. Interest in the technology has resurfaced with the diffusion of microcomputers into clinics, offices, schools, community centers, and homes. It is conceivable that, if left undisturbed, market forces might eventually eliminate quality-deficient health instructional software programs. But today's potential market for computer-assisted instruction is large and poorly informed. The rapid diffusion of the microcomputer throughout society has given millions of people, including older people, access to computer-assisted health instruction that did not exist 10 or 15 years ago. As the number of people with access to computers soars in the future, the number of users who lack the expertise to properly evaluate the content of instructional programs will also rise.

Government involvement in generalized descriptive programs that do not differ from published materials would be hard to justify because of the protection afforded publications by the First Amendment. But reputable developers of computer-assisted health instructional material attempt to produce programs that do not mimic published matter. The nature of the computer allows for an interactive exchange between the user and the program, which is rarely possible between the reader and a book or other publication. Proficient software developers thus attempt to invoke active user participation in constructing their software programs. Whether the Government can assume a role with respect to the quality of interactive instructional software programs has not been determined.

A serious issue arises about actions to be taken in cases where incorrect or inexact information is used in software programs that instruct individuals how to manage mental health problems and how to use drugs or medical devices to manage medical conditions. Such information may adversely affect the health status of the user. Because of its general role of protector of the public and its specific role of user of and payer for health technology, the Government is concerned with issues of safety and effectiveness. And the Goverment has found it necessary to assure the safety and effectiveness of health technologies, such as drugs and medical devices, on which the life or death of the user may depend.

1.2: Congress could encourage Federal involvement in validating the quality of the content of health instructional software for the older population.

1.2.a: Congress could require that the Food and Drug Administration (FDA) regulate the safety and effectiveness of the content of all health instructional software for the elderly.

The FDA is currently responsible for regulating the safety and effectiveness of all new drugs and certain medical devices before they are marketed. There is also legal precedent for the FDA to classify certain types of software as medical devices (34). Although manufacturers of medical devices are required by law to conduct tests of safety and effectiveness using FDA guidelines, the definition of effectiveness employed by FDA has limited utility for evaluating the health effects of medical devices under general conditions of use. On the one hand, FDA considers a device to be effective when, on the basis of well-controlled investigations or other valid scientific evidence, the device is shown to have the effect claimed by the manufacturers under the specified conditions of use (21 U.S.C. §260(c)(3)). On the other hand, the Health Care Financing Administration (HCFA) judges the effectiveness of a medical device in terms of its ability to improve health. Thus some devices approved by FDA for marketing purposes are not covered by HCFA for payment under Medicare or Medicaid (79).

The FDA does not have a policy governing the regulation of software used in computer-assisted health instructional programs, but the FDA Task Group on Computers and Associated Software as Medical Devices is studying the issue (31). The problem is determining which types of programs can be considered medical devices. Preliminary decisions are that information management systems and programs that merely transfer information, such as databases, are not medical devices and thus not subject to FDA regulation. Software that describes self-testing, diagnosis, or treatment may be considered to be a medical device except in cases where the software merely copies instructions, i.e., serves as an "automated" book. If the content has been manipulated in any way and concerns diagnosis or treatment, current thinking holds that the software may be considered a medical device.

1.2.b: Congress could charge another established governmental body, or create another governmental body, with responsibility for regulating the safety and effectiveness of the content of software for health instructional material not concerning drugs or medical devices for the elderly or for all health instructional software.

There is no Federal agency, including the FDA, specifically charged with evaluating surgical and medical procedures, including therapeutic counseling, before such services are performed. The quality of the service is governed by the governmental licensure and professional certification of the providers of the service, and the professional accreditation of the providers' educational facilities. Medicare coverage also serves as a minor control of the safety and efficacy of surgical and medical procedures as well as drugs and devices used for the elderly (61). HCFA requires a determination—a coverage decision—of the safety and efficacy of technologies before it will reimburse providers for their use with Medicare beneficiaries.

The FDA does not currently have the expertise to regulate medical products other than drugs and devices. However, as noted previously, the agency is considering the issue of regulating instructional software. The staff could be expanded to include professionals who have the requisite expertise, or professionals from other agencies who have content knowledge could be consulted. Creating a separate body for this one purpose runs counter to current administrative philosophy and operations.

1.3: Congress could stimulate the development of standards for assessing the safety and effectiveness of content of software for computer-assisted health instruction programs for the older population. (This option is independent of options 1.1 and 1.2).

Recognized formal standards for use in evaluating the science base or the instructional strategy embedded in computer-assisted health instructional programs for the elderly have not been developed by either the public or the private sector. The director of the Office of Disease Prevention and Health Promotion has decried the lack of a science base and evaluation of the software used for health education programs (44). He notes that "many programs have been written by persons with inadequate background in health or health education, and are not being properly reviewed." Moreover, the quality of the instructional notebooks of computer-assisted health programs for the older person has received little attention. Because the way in which information is presented affects the use of the information, a program needs logic and completeness. The task is timely and costly. Although there is a need to address the problems associated with the development of health instructional software, the field is too new to have created voluntary standards to cope with such rapid technological change.[6]

At the present time there is marginal activity among members of the academic community in establishing standards to evaluate the quality of health instructional software (14,32). As has been noted, the FDA is classifying types of software as to their standing as medical devices. At the same time, the FDA is developing standards for assessing those software programs that are classified as medical devices. However, the standards to be used by the FDA in future evaluations are expected to be limited to assessment of the algorithm, or computing method, used in structuring the software program and in implementing the program. If an algorithm relies on various tests of predictive accuracy, including both sensitivity and specificity, the program should perform satisfactorily. However, as a 1981 report by the General Accounting Office (GAO) points out, assessment of an algorithm does not always assure that the science content of a software program is accurate. GAO noted a number of cases in which FDA had evaluated a software program and the medical devices were defective because the software program used by the manufacturer in the medical device was based on calculations unacceptable to the scientific community (59).

Even if the FDA were to expand and modify its evaluation methodology, the FDA process for developing standards has proven very cumbersome. For example, no mandatory performance standards have been developed for Class II medical devices since Congress passed the Medical Device Amendments of 1976. Indeed, the 1981 GAO report notes the need to develop alternatives to FDA's performance standards so that assurance can be given within a reasonable period of time that the software of medical devices in general operates as expected.

Neither current nor proposed FDA activities preclude the development and use of standards by the private sector, which has initiated many standards in the health field. Voluntary standards can be used in various ways. In some cases, voluntary standards are used solely by their developers, usually an industry, to guide the development of its products and services. In other cases, they have formed the basis of governmental standards; e.g., accreditation standards of the Joint Commission on the Accreditation of Hospitals (JCAH) are the basis for Medicare's conditions for hospital participation in the program. JCAH's accreditation standards are also used by the private sector to assure the quality of hospital care.

Many professional groups and private enterprises are involved in the research and development of software programs for health instruction purposes, and their number is growing. There is, however, insufficient official communication among the organizations, and no one type of organization has taken the lead in developing voluntary standards for use in evaluating the quality of the content of health instructional software.

One way in which Congress could encourage the process of developing criteria for use in evaluating health instructional materials for the elderly is to encourage the convening of a conference or workshop on the problem. Participants could represent all interested parties, including manufacturers of computers and software, software programmers, researchers in computer science and education, health professionals, educators, consumers, and relevant Government bodies. The conference would illustrate congressional recognition of the need for evaluation standards, initiate a process for their development, and facilitate the cooperation of those with expertise in their formulation.

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[6] Voluntary standards are generally established by private sector bodies and are available for use by any person or organization, private or governmental (OMB Circular A-119, revised, Oct. 26, 1982).

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Chapter 7

Technologies, Functional Impairment, and Long-Term Care

Contents

Page
Introduction 185
What is Long-Term Care 185
The Need for Long-Term Care 185
Government Involvement in Long-Term Care 186
Technology and Long-Term Care 187
The Influence of Federal Funding Mechanisms on the Long-Term Care System 188
Functional Impairment and the Need for Long-Term Care 189
Functional Impairment in the Elderly Population 190
Causes of Functional Impairment 191
Long-Term Care Services 194
Informal Long-Term Care 194
Formal Long-Term Care Services and Settings 195
Issues in Long-Term Care Settings and Services 204
Technologies in Long-Term Care 207
Assessment Technologies 207
Assistive Devices and Rehabilitation Techniques 212
Technologies for Caregivers 220
Long-Term Care Delivery Systems 225
Findings 232
Research Priorities 234
Issues and Options 235
Use of Assessment Measures 235
Functional Impairment 235
Rehabilitation Technologies 236
Service Delivery Systems 237
Technical Memorandum: Federal Programs Funding Long-Term Care Services 237
Medicare 237
Medicaid 238
Title XX 239
Title III 239
Supplemental Security Income 239
Veterans Administration 240
Chapter 7 References 240

Tables

Table No. *Page*
12. Public Expenditures on Long-Term Care Service by Program, Fiscal Year 1980 187
13. Number of Individuals and Rate per 1,000 Who Need the Help of Another Person in One or More Selected Activities by Age: United States, 1979 192
14. Most Frequent Preexisting Health Conditions and Functional Dependencies 193
15. Elements of Long-Term Care in the Home 201
16. Examples of Assistive Devices for the Functionally Impaired Elderly 213
17. Behavior Problems of Patients Cited by Families 223

Figures

Figure No. *Page*
19. Dependency in Basic Physical Activities Because of a Chronic Health Problem, by Type of Activity and Age: United States, 1979 191
20. Dependency in Home Management Activities Because of a Chronic Health Problem, by Type of Activity and Age: United States, 1979 192
21. Source of Support for the Disabled Elderly, Cleveland, OH, 1975 194
22. Percentage Distribution of Nursing Home Expenditures in the United States, 1979 197
23. Percent of Nursing Home Residents Who Need Assistance With Basic Physical Activities, 1977 197

Chapter 7

Technologies, Functional Impairment, and Long-Term Care

Introduction

Long-term care for the elderly includes a variety of health and social services provided for individuals who need assistance because of physical or mental disability. The increasing number of elderly persons in our society, particularly those over 85 who most frequently need long-term care, is expected to intensify the demand for services and place additional strain on agencies, delivery systems, and funding programs. This chapter examines Federal concerns in long-term care, the needs of the disabled elderly, and technologies appropriate for addressing those needs and improving services and service delivery. These technologies include:

- assessment technologies to identify functional impairments and facilitate matching of the individual with long-term care services;
- technologies to maintain or increase independent functioning, including assistive devices and rehabilitation services;
- technologies to assist formal and informal caregivers; and
- service delivery systems to improve access to appropriate long-term care.

Discussion focuses on problems that impede the use of available technologies and limit the development of new technologies.

What is long-term care?

Although there is no single accepted definition of long-term care, it is generally agreed that the goal of long-term care is to maintain or improve the ability of the individual to function as independently as possible and that services will be needed over a prolonged period, even if they are only needed intermittently. Medical care is seen as an essential component of long-term care, but a variety of other services are also considered important (44).

Long-term care is generally concerned with functional impairments, such as limitations in the individual's ability to move around independently; to feed, dress, or bathe himself; or to perform housekeeping functions such as shopping, cooking, or cleaning. While acute care is most often directed toward treating or curing disease, long-term care is generally directed toward compensating for functional impairment and maintaining or improving the functional capacity of the individual.

In the past, definitions of long-term care have often encompassed only services provided in institutional settings such as nursing homes and extended-care facilities, but most recent definitions include a broader range of services that may be provided in an institution or in the home or the community (68,109). The following definition, developed for the 1981 White House Conference on Aging, emphasizes the broad range of services and the kinds of individuals served:

> Long-term care represents a range of services that address the health, social, and personal care needs of individuals who, for one reason or another, have never developed or have lost the capacity for self-care. Services may be continuous or intermittent, but it is generally presumed that they will be delivered for the "long-term," that is, indefinitely, to individuals who have demonstrated need usually measured by some index of functional incapacity (130).

Although long-term care services are needed by some disabled individuals of all ages, this chapter addresses only the long-term care needs of the elderly.

The need for long-term care

Estimates of the number of elderly individuals who need long-term care services depend on the definition of long-term care that is used and the kinds of impairments that are seen to create a need for long-term care. About 7 percent of individuals 65 to 74 and more than 40 percent of those over 85 have functional impairments that may indicate a need for long-term care. Many of these individuals are not using formal long-term care services: some receive assistance informally from family or friends; others live in communities that lack the formal services they need. Some elderly individuals cannot pay for services and are not eligible for those provided by government programs. Others are not aware of available services or simply prefer not to use formal long-term care services.

At present there are almost 1.3 million elderly individuals in nursing homes at any one time. Another 150,000 to 200,000 elderly individuals are residents of board and care facilities (88), and many elderly persons are receiving one or more long-term care services in their homes or communities.[1] Adult day care facilities, hospice programs, and congregate housing facilities also provide long-term care services in some communities.

The need for formal long-term care services is expected to increase dramatically in the future as a result of rapid growth in the number of elderly individuals in the population (see ch. 2). One researcher has estimated that the number of elderly individuals in nursing homes will rise by more than 50 percent by the year 2000 (29), requiring construction of up to 10,000 new nursing homes. Demand for other long-term care facilities and services can be expected to increase proportionately. Factors that would alter these projections are changes in the prevalence of chronic disease and functional impairment among the elderly and in the ability and willingness of family and friends to provide long-term care services informally.

Over the past 50 years, advances in public sanitation, hygiene, and medical care have lowered mortality from infectious diseases, and individuals who might have died earlier of these causes now live long enough to develop functional impairments related to chronic diseases. Medical treatment has also lowered mortality from heart attacks, strokes, and some cancers, but there is currently no evidence that the onset of chronic disease and functional impairment has been postponed (98). Future medical advances that reduce mortality for the elderly may result in greater numbers of elderly individuals with chronic diseases that lead to functional impairment (81), thus increasing the need for long-term care. Yet medical research focused specifically on the chronic conditions that cause functional impairment could result in methods of treatment or prevention that would significantly decrease the number of elderly individuals needing long-term care (29,81).

Changes in regulations for government programs that fund acute care services can also affect demand for long-term care. For example, recent changes in Medicare reimbursement for hospital care are increasing the demand for long-term care services. The prospective reimbursement system based on diagnosis-related groups (DRGs) instituted October 1, 1983, has created incentives for early discharge of hospital patients. Many elderly individuals who are discharged earlier from hospitals need continuing convalescent care in nursing homes or in the community. Technologies that have been available primarily in hospitals are also needed in alternative settings in the community to care for these individuals.

Government involvement in long-term care

Current government involvement in long-term care includes funding and regulation of many long-term care services through Federal programs such as Medicare, Medicaid, Supplemental Security Income (SSI), the Title XX Block Grant, Title III of the Older Americans Act, and services provided through the Veterans Administration (VA). (These programs are described in the technical memorandum at the conclusion of this chapter.) State and local governments participate in funding and regulation of services provided through these Federal programs and also fund and regulate some long-term care services of their own. Public spending for Federal programs providing long-term care services in fiscal year 1980 is summarized in table 12.

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[1] In 1980, about 890,000 elderly individuals received home health care services funded by Medicare, and about 140,000 elderly individuals received Medicaid funded home care services (126). There are no reliable estimates of the number of elderly individuals who paid privately for home care services.

Table 12.—Public Expenditures on Long-Term Care Service by Program, Fiscal Year 1980[a]

Service category	Total reported expenditures in U.S. (thousands of dollars)	Percentage distribution by program[b]					
		Medicaid	Medicare	Title III Older Americans Act	Supplemental Security Income	Title XX	Veterans Administration[c]
Total	$13,454,224.2[d]	76.3%	6.9%	5.2%	2.7%	5.4%	3.5%
Nursing home	8,586,008.0	92.3	3.6[e]	*[f]	—	—	4.1
Board and care	505,991.4	—	—	—	73.1	4.0[g]	22.9
Adult day care	20,585.9	3.3	—	—	—	96.7	—
Home health	775,383.3	18.2	80.8[h]	—	—	—	1.0
Personal care and housekeeper chore	667,602.4	32.6	—	6.3	—	61.1[i]	—
Community	462,147.2	—	—	45.2[j]	—	54.8[k]	—

*Less than 0.05 percent.

[a] These programs serve individuals of all ages, not only the elderly.

[b] Each of these programs is described in the technical memorandum at the conclusion of the chapter.

[c] Expenditures for fiscal year 1979.

[d] This column does not total because some services that are not discussed in this chapter and services for retarded adults are not included.

[e] Expenditures for calendar year 1979.

[f] Nursing home ombudsman services—$3,789.0 thousand.

[g] Residential care and treatment services.

[h] Expenditures for calendar year 1980.

[i] Includes services reported under the following categories: homemaker, chore, and home management.

[j] Includes access, community (other than legal), and in-facility services.

[k] Includes services reported under the following categories: special services for the blind, education and training, transportation, health related, special services for the disabled, other, socialization, transitional case management, protective services for adults, placement, housing, improvement, counseling, recreational, diagnosis and evaluation, and emergency.

SOURCE: Cohen, 1983 (25).

Rising public expenditures for long-term care services are a major concern of government at all levels. Public spending for long-term care has increased sharply over the past 20 years and is expected to continue growing as a result of increases in the number of elderly persons, expansion of services, and escalating health care costs. For example, more than one-third of all Medicaid expenditures are now for nursing home care. Despite Federal and State efforts to contain costs, expenditures for nursing home care continue to grow (119), threatening the capacity of the Medicaid program to provide other benefits for indigent elderly and nonelderly recipients.

In addition to rising costs, another major governmental concern in long-term care is the availability of appropriate services for the disabled elderly. Although there is currently no comprehensive Federal policy on long-term care, the programs cited earlier reflect government intent to provide for some of the long-term care needs of the elderly. Relevant public policy issues include:

- availability of long-term care services in local communities;
- access to these services, including information and referral, and funding;
- appropriate matching of the needs of the individual and the services provided;
- provision of services in the least restrictive setting; and
- quality of available services.

Government concern for controlling public expenditures in long-term care appears to conflict with government efforts to assure access to appropriate long-term care services (81). Increased use of technology can address both concerns. Biomedical research on chronic disease and rehabilitation technologies that help to maintain or improve independent functioning may decrease the need for long-term care, thus limiting costs and improving quality of life for the elderly. Assessment technology and technologies to assist caregivers and improve the service delivery system can lead to more appropriate treatment and more efficient use of available resources.

Technology and long-term care

Technology has traditionally been given very little emphasis in long-term care. The importance of functional impairments in causing the need for long-term care has been cited repeatedly in research reports and government publications, but the role of technology in compensating for functional impairments has received relatively little attention. Assessment technologies to identify functional impairments have not been widely used outside research and demonstration projects and specialized geriatric assessment centers. Long-term care providers, including nursing homes and informal caregivers such as family and friends, have not generally used available technologies to facilitate caregiving and improve quality of care.

Some specific reasons for the lack of emphasis on these technologies are discussed later in this chapter. One common factor that limits the use of these technologies is the overriding emphasis on medical care and skilled nursing care in the Federal programs that fund long-term care services. By defining need in terms of medical and skilled nursing care, these programs tend to obscure other needs, including the need for technologies to identify and compensate for functional impairments and assist caregivers and the need for alternative forms of care.

The influence of Federal funding mechanisms on the long-term care system

At present Medicare and Medicaid pay almost half the total cost of nursing home care in this country, and more than half of all nursing home patients are paid for in part by these public programs.[2] It is estimated that Medicare and Medicaid also pay for more than half of all home care in this country (94). As a result, Medicare and Medicaid regulations that define eligibility for services affect a very large proportion of those receiving long-term care.

In addition to defining eligibility requirements, Medicare and Medicaid regulations define the kinds of services covered, the kinds of agencies certified to provide reimbursed services, and minimum standards for the number and qualifications of personnel employed by these agencies. State governments can add to Federal requirements, and some agencies provide services and staffing above Medicare and Medicaid guidelines, but because cost containment is a constant concern, many agencies limit their services and staffing to Medicare and Medicaid requirements. Even individuals who pay privately for long-term care services may be affected by Medicare and Medicaid regulations because the agencies that provide services to them are often structured and staffed to meet these requirements.[3]

Medicare and Medicaid were enacted in 1965 primarily to provide medical care for the elderly and the poor, with emphasis on acute care in the hospital and the physician's office. Medicare coverage for nursing home care was designed to provide skilled nursing care immediately following hospitalization. Medicaid coverage for long-term care was intended to assure adequate health care services for low-income persons but not to provide supportive or custodial care.

Since their inception, both programs have been stretched to provide some services that are not medically related, but the emphasis remains on medical care. Eligibility for Medicare-funded nursing home care depends primarily on medical diagnosis and the need for skilled nursing care, and Medicare-funded home care services are health-related services authorized by a physician. Eligibility for most nursing home and home care services funded by Medicaid depends on medical condition.

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[2] Using 1976 data, the General Accounting Office estimated that 54 percent of elderly nursing home residents were receiving some Medicaid support (119); other data indicate that the figure may be as high as 75 percent (134).

[3] Although some facilities, agencies, and providers do not provide services for any Medicare or Medicaid reimbursed patients and so are not affected by Medicare and Medicaid regulations, most facilities serve both Medicare or Medicaid patients and individuals who pay privately for their care. In these agencies, the services and staff available to private-pay patients are often determined indirectly by Medicare and Medicaid regulations.

Because Medicare and Medicaid fund such a large proportion of long-term care services, the emphasis on medical diagnosis and medical treatment in these programs tends to define the kinds of long-term care needs that are recognized and the services and technologies that are available.[4] Physician services and prescribed medical treatment are obviously very important for impaired elderly individuals, and accurate medical diagnosis is essential for planning medical and nonmedical care, but evaluation of appropriate technologies for this population requires recognition of needs for both medical and nonmedical forms of care. The following examples illustrate how the emphasis on medical and skilled nursing care in Federal funding programs can lead to inappropriate treatment and distort data on the need for long-term care.

> The family and physician of an elderly individual who is mentally confused decide that he can no longer live alone and that a nursing home is the only available option for 24-hour care. Because he cannot afford to pay the monthly bill, he is admitted to the nursing home under Medicaid, with a diagnosis of chronic heart disease and a treatment plan that emphasizes the need for medical care. (This diagnosis and treatment plan are necessary to establish eligibility for Medicaid funding.) In the nursing home, which is structured and staffed to provide physical care, the confused patient is placed on a wing with physically impaired patients and treated as if he were physically impaired. Technologies and care methods appropriate to deal with his confusion are not used. A survey of nursing home residents will later pick up the diagnosis and treatment plan from his chart, and the fact that he was admitted because of mental confusion will be lost.
>
> An elderly woman with severe osteoarthritis needs some personal care services such as help with bathing or dressing and some related housekeeping services in order to continue living independently Medicare regulations specify that in order to justify reimbursement for these services, skilled home health care services such as nursing, physical therapy, speech therapy, or occupational therapy must also be needed. The home care agency has a choice of not providing the needed personal care services or of sending out a skilled professional to visit the patient to justify continuing visits of the home health aide, who provides personal care. If services are provided, the patient's records will show that she needed skilled care although she and the service providers know that she needed primarily personal care and housekeeping assistance.[5]

Functional impairment and the need for long-term care

Despite the emphasis on medical diagnosis and medical care in the existing long-term care system, virtually all research on the long-term care needs of the elderly shows that medical diagnosis is usually not a good predictor of the need for services. Individuals with the same diagnosis vary greatly in their need for long-term care. For example, some individuals with heart disease, chronic respiratory disease, or degenerative osteoarthritis need to be in a nursing home; others manage well on their own. The important factor in determining the need for long-term care, including both formal and informal services, is the functional status of the individual; i.e., which functions he or she is able to perform and which functions he or she needs help with (50,68,140).

In fact, the elderly often measure their own health in terms of functional impairment. They may say that they are in good health when they

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[4] Many long-term care agencies have been created since Medicare and Medicaid came into effect and have designed their programs to serve Medicare and Medicaid patients and conform to relevant Federal regulations.

[5] Surveys based on a review of patient records cannot pick up these instances of inappropriate treatment because patient records must be written to show that the patient needed services that are reimbursable under Medicare and Medicaid, or payment will be denied. Only an independent assessment of patient needs could provide accurate data.

Photo credit: Phylis Eisen

Many elderly individuals function independently despite underlying chronic conditions.

are able to function independently in spite of underlying chronic diseases (68). Likewise, they may fear the frailty and dependency associated with functional impairment more than specific diseases (53). While chronic diseases often cause functional impairment, it is functional impairment that most often leads to a need for long-term care.

The distinction between chronic disease and functional impairment is very important in identifying long-term care needs and technologies that are appropriate for addressing these needs. Technologies that do not affect underlying disease conditions but improve the functional status of the individual can decrease the need for long-term care. For example, devices or techniques that allow an individual to bathe, dress, and feed himself will decrease his need for long-term care services. In contrast, medical treatments that alter disease conditions but do not improve functional status will not affect the need for long-term care. Thus, an individual with heart disease, hypertension, and degenerative osteoarthritis may need assistance in functioning only because of the osteoarthritis; medical treatment to control the hypertension will not affect his current need for long-term care services.

Precise medical diagnosis is essential for the treatment of disease, and diagnoses are available for many elderly patients, yet they often do not specify the disease conditions that are causing functional impairment. Diagnosis related to functional impairments is important for planning treatment because while long-term care patients often have several diagnoses, including some presently incurable diseases, the condition that is causing the need for long-term care may be curable. For example, incontinence, which has been cited as the cause of nursing home placement for many patients, may often be treatable, allowing the possibility that the patient could return home even when his other chronic disease conditions are unchanged.[6]

Functional impairment in the elderly population

The extent of functional impairment among the noninstitutionalized elderly is illustrated in the following graphs which show the rates of dependency in six basic physical activities (fig. 19), and in home management activities (fig. 20). These illustrations highlight the relationship between increasing age and functional impairment. Rates of dependency for each activity at least double between each age category and triple between ages 75 to 84 and over 85. The very old, those over 85, are from 5 to 10 times more likely to need assistance with these activities than the young-old, those who are 65 to 74.

Among the noninstitutionalized elderly, more than 425,000 individuals are bedridden, including about 1 percent of those 65 to 74 and more than 5 percent of those over 85. About 800,000 individuals over 65 either have a device to control bowel or bladder function or have other trouble with bowel or bladder control; this figure includes about 2 percent of those 65 to 74 and about 11 percent of those over 85 (129).

Overall estimates of the number of noninstitutionalized individuals who need assistance from another person in some daily activity are shown in table 13, which again illustrates the dramatic increase in need for assistance with increasing age. Almost 44 percent of those over 85 need or are receiving assistance with some daily activities. As the number of individuals in this age group

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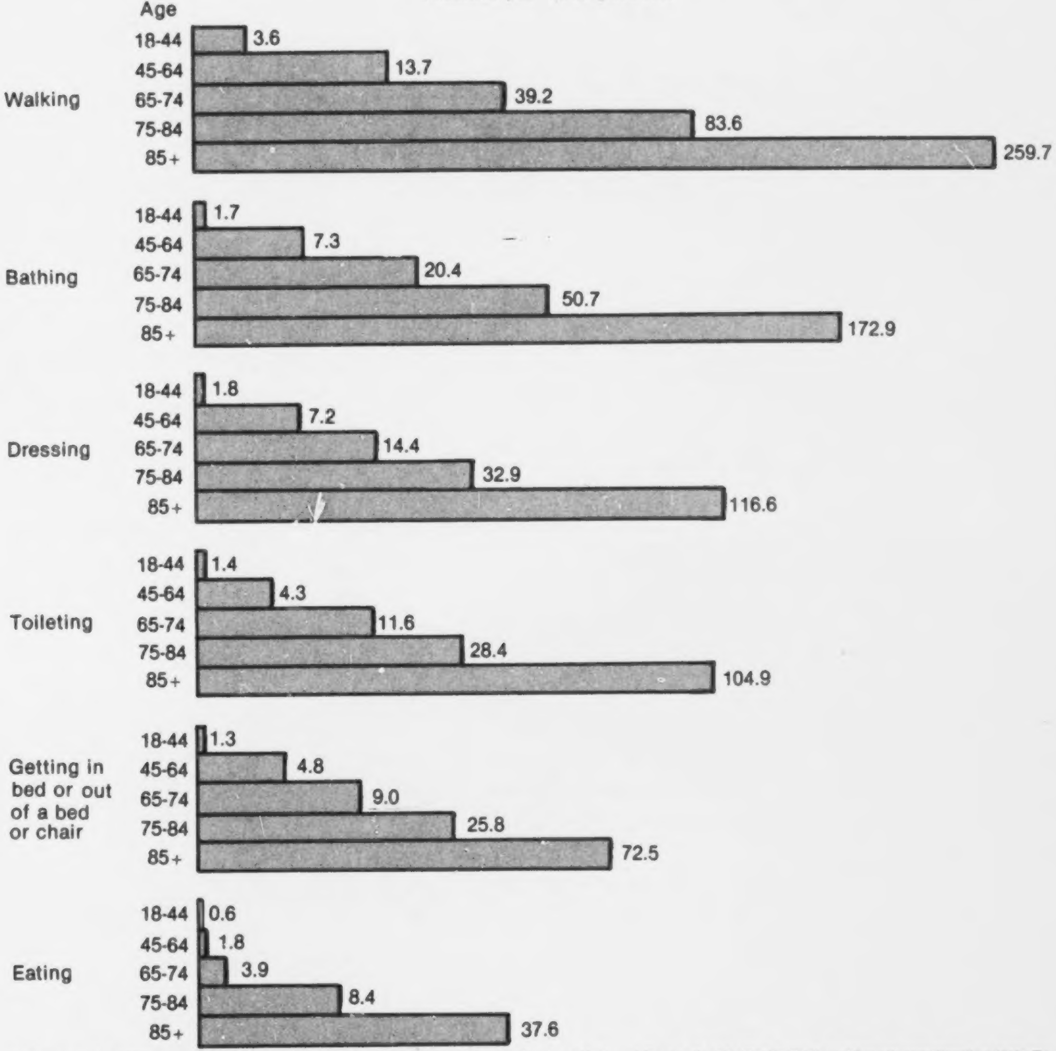
[6] Medical diagnosis related to functional impairment could also provide valuable information for government planning and policymaking since the need for most long-term care services is dependent on the prevalence of disease conditions that cause functional impairment. Although the annual Health Information Survey conducted by the National Center for Health Statistics provides data on the prevalence of acute and chronic conditions and the prevalence of disability and impairment, there is currently no way to identify which acute and chronic conditions are causing disability and impairment because medical diagnoses related to specific impairments and disabilities are generally not available.

Figure 19.—Dependency in Basic Physical Activities Because of a Chronic Health Problem, by Type of Activity and Age: United States, 1979

Number per 1,000 persons



SOURCE: U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, "Americans Needing Help To Function at Home," No. 99, Sept. 14, 1983.

grows, the need for formal and informal long-term care services will increase rapidly.

Causes of functional impairment

Many acute and chronic diseases and mental and emotional disorders can limit the ability of the older individual to function independently. (The prevalence of chronic disease in the elderly is discussed in app. A.) Chronic diseases with especially high prevalence among the elderly include heart disease, hypertension, arteriosclerosis, osteoarthritis, diabetes, and diseases of the urinary system. In some individuals these diseases result in inability to perform basic self-care and home management activities. Vision and hearing impairments are also very common among the elderly and frequently cause functional impairment.[7]

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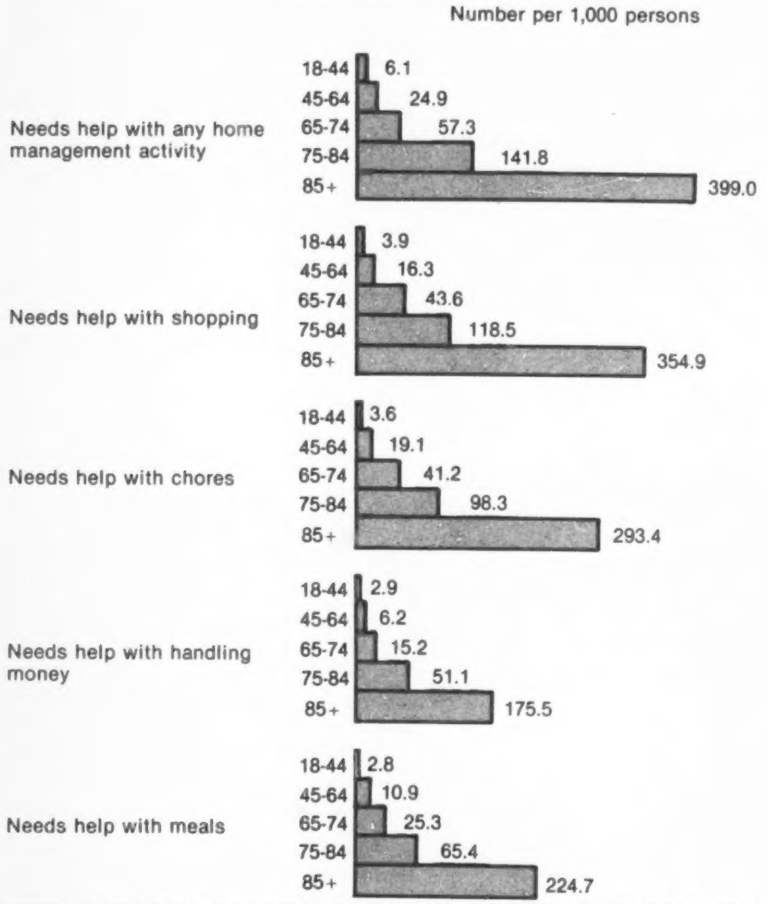
[7] The functionally impaired elderly include both those who become disabled after age 65 and those who were disabled at earlier ages but are now over 65. This latter group can be expected to increase significantly as a result of biomedical advances that prolong the lives of developmentally disabled and physically handicapped individuals.

Figure 20.—Dependency in Home Management Activities Because of a Chronic Health Problem, by Type of Activity and Age: United States, 1979



SOURCE: U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, "Americans Needing Help To Function at Home," No. 92, Sept. 14, 1983.

Table 13.—Number of Individuals and Rate per 1,000 Who Need the Help of Another Person in One or More Selected Activities by Age: United States, 1979

	Needs help of another person	
Age	Number in thousands	Rate per 1,000
45-64	1,357	31.2
65-74	1,043	69.2
75-84	1,101	160.3
85+	674	436.5

SOURCE: U.S Department of Health and Human Services, Public Health Service, National Center for Health Statistics, "Americans Needing Help To Function at Home," *Advancedata*, No. 92, Sept. 14, 1983.

Acute conditions that can cause functional impairment among the elderly include those resulting from untreated infections and drug interactions. The complex relationship between the need for acute medical care and long-term care among the elderly is not discussed in this chapter, but it should be noted that the need for long-term care for an elderly individual is often first recognized when the individual is hospitalized for an acute medical condition. Once this condition has been treated, it becomes obvious that the individual is not able to function independently and may have needed long-term care services even before the acute condition developed.

Mental and emotional conditions that cause functional disability include organic conditions such as Alzheimer disease and multi-infarct dementia, and functional disorders such as depression. It is estimated that 5 to 15 percent of individuals over 65 have Alzheimer disease (123), and 2 to 7 percent have clinically diagnosed depression (36). Estimates of the extent of undiagnosed depression in the elderly are much higher.

The relationship between mental and emotional conditions and functional impairment in elderly individuals has received little research attention, but a recent study by Brody and Kleban (15) compared functional impairment in three groups of elderly individuals: those with normal mental functioning, those with a history of diagnosed functional mental illness for which inpatient or outpatient treatment had been received, and those with senile dementia. The chronic diseases and functional disabilities of these groups are presented in table 14.

The researchers point out that although almost all the subjects had one or more chronic conditions, the mentally normal group was basically independent in self-care and home management activities; the group with functional mental disorders was somewhat more dependent, with a significant proportion needing help with home management activities; and the individuals with senile dementia were most dependent, with a large proportion needing help with personal care and almost all needing assistance with home management activities. Dementia was highly correlated with functional impairment.

Other studies also indicate a correlation between dementia and functional impairment. For example, special tabulations of survey data on nursing home and community dwelling older persons indicate statistically significant correlations between impaired cognitive ability and incontinence of bowel or bladder (Pearson correlations ranged from 0.63 to 0.73) (86). These data agree with findings of Ouslander, et al. (75), that the majority of incontinent patients in seven nursing homes studied were also cognitively impaired. Patients with frequent incontinence were significantly more likely to be cognitively impaired than those with occasional incontinence.

The relationship between mental confusion and functional impairment is a very important consideration in the development of technology for long-term care because technologies that are appropriate for individuals who are not confused are often inappropriate for those who are confused. Organic brain disease is known to cause a progressive decline in the individual's mental functioning and self-care abilities: patients become

Table 14.—Most Frequent Preexisting Health Conditions and Functional Dependencies (percentage by groups)

Preexisting health conditions	Normal	Functional	Senile dementia	Dependent in	Normal	Functional	Senile dementia
Arthritis	66	63	56	Toileting	0	0	35
Foot trouble	45	35	35	Feeding	0	0	26
Visual impairment	33	56	56	Dressing	2	5	50
High blood pressure	33	41	53	Grooming	0	7	47
Circulation problems	31	26	62	Home mobility	0	2	29
Hearing impairment	27	43	26	Bathing	2	16	79
Diabetes	25	9	24	Cutting toenails	16	44	91
Elimination problems	22	52	59	Telephoning	0	2	62
Digestive problems	14	33	38	Shopping (food)	16	35	97
Nervous breakdown	0	40	0	Food preparation	2	9	79
				Housekeeping	10	23	88
				Laundry	8	26	94
				Transportation	8	30	82
				Taking medications	2	5	82
				Handling finances	4	14	97

NOTE: Data for normal and functional groups obtained from subjects: data about dependencies of senile dementia group obtained from collaterals.

SOURCE: Brody and Kleban, 1983 (16).

increasingly forgetful and confused and eventually may become unable to dress, bathe, and feed themselves because they cannot remember how; they become incontinent because they cannot find the bathroom or remember how and when to use a bathroom. About 50 percent of nursing home residents have symptoms of confusion, but it is not known how many or what proportion of these individuals are unable to care for themselves as a result of confusion and how many are functionally impaired as a result of other chronic physical conditions. Some individuals may be functionally impaired as a result of both mental confusion and physical conditions. Identifying the cause of functional impairment is crucial for the appropriate use of rehabilitation technologies with these patients.

Long-term care services

The existing long-term care system includes services provided informally by family and friends and formal services provided in institutions, in the community, and in the patient's home. The following description of the kinds of individuals who are receiving services and the characteristics of the agencies and caregivers provides a background for the identification and evaluation of technologies appropriate for these patients, agencies, and caregivers.

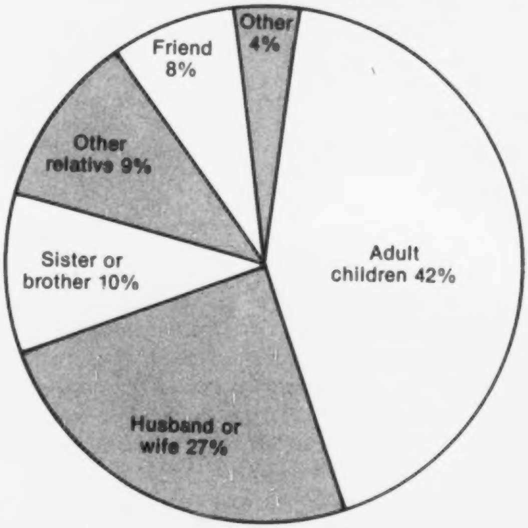
Informal long-term care

Families play a predominant role in providing long-term care services for the elderly. A 1975 study by the General Accounting Office (GAO) of the elderly population in Cleveland, OH, concluded that families were providing more than 50 percent of all long-term care services received, and that as the impairment level of the individual increased, so did the proportion of services provided by the family. For the extremely impaired group, families provided 80 percent of needed services (115).

While the spouse and adult children of the disabled elderly are the most frequent source of informal support, other relatives and friends also provide assistance: of the 87 percent of elderly subjects in the Cleveland study who identified an individual as their primary source of help, most cited adult children or their spouse, but a significant number named a brother or sister, another relative, or a friend (114) (see fig. 21).

Informal support provided by family and friends can help to avoid or delay institutionalization, and elderly persons who live alone are at greater risk of nursing home placement. The GAO study found that of those persons who were institutionalized during the following year, none had been living with spouse or adult children, and three-fourths had been living alone (115). Similarly, a study of severely disabled elderly people receiving services from a home care agency in Philadelphia showed that none of the individuals lived alone: 46 percent lived with their children, 20 percent lived with a spouse, and 34 percent lived with other relatives and friends (18).

Figure 21.—Source of Support for the Disabled Elderly, Cleveland, OH, 1975



SOURCE: U.S. Congress, U.S. Comptroller General, General Accounting Office, Apr. 19, 1977 (114).

Several recent reports suggest that the increase in numbers of working women may limit the availability of family members to care for the impaired elderly (11,96,113). Although no statistics are available to test this hypothesis, a study of the attitudes of elderly women, their daughters, and granddaughters found that the daughters, and particularly the granddaughters believe that the elderly should be able to depend on their families to help them. At the same time, the respondents agreed that working daughters should not quit their jobs in order to care for elderly parents (16). These findings are significant because daughters provide the great majority of informal supports to elderly parents.

The availability of technologies to lessen the burden of caregiving could increase the ability and willingness of families to keep elderly relatives at home. These technologies include:

- assistive devices that increase the ability of the impaired individual to perform some functions independently;
- devices and procedures that help with lifting, turning, transferring, bathing, dressing, and feeding functionally dependent persons;
- devices and procedures to assist with the problems of the mentally confused individual, such as wandering, forgetfulness, being up all night, and the catastrophic emotional reactions that characterize some Alzheimer disease patients;
- home care systems to provide services the caregiver cannot provide and to teach caregiving procedures; and
- respite care systems provided in the home or community that temporarily relieve the caregivers of their responsibilities.

Technologies to facilitate physical care may be particularly important for the spouse and adult children of the impaired elderly because these individuals are often elderly themselves and may have chronic conditions that limit their energy, strength, and capacity to provide physical care. Several recent reports have also documented the value of support groups in providing information and emotional support for caregivers. These technologies are discussed later in this chapter.

Formal long-term care services and settings

Formal long-term care services are provided in nursing homes, board and care facilities, and in the elderly person's home. Adult day care, hospice care, respite care, and congregate housing services are also available in some communities. These services are often said to form a continuum of care arranged to reflect the elderly person's increasing need for assistance. At one end of the continuum are inpatient facilities providing 24-hour skilled nursing care, and at the other end are community agencies that provide supportive services such as meals-on-wheels, chore services, and transportation for the elderly. In between are board and care facilities that offer personal care on a 24-hour basis and home health agencies that provide skilled nursing care and personal care in the home.

The continuum of care concept reflects a combination of two underlying questions about the individual's need for care. The first is whether the individual needs 24-hour care; that is, can the individual safely be alone at all? The second question concerns exactly what kind of care the individual needs: skilled nursing care, personal care, or supportive care. Skilled nursing care includes medically prescribed treatments such as tube feedings, dressings, catheterization, and monitoring of medical conditions that can only be done by a trained nurse. Personal care includes services such as bathing, dressing, feeding, and assisting the patient to get up and get to the bathroom, while supportive services include shopping, housekeeping, chore service, and transportation.

In the past, few formal long-term care services were available in the home, and individuals were sometimes admitted to nursing homes for skilled nursing care or personal care even when they did not need 24-hour care. In some communities this is still true, but in other communities skilled nursing care, personal care, and supportive services are available both in institutional settings and in the home. The availability of home care services makes it increasingly important to carefully assess the individual's need for 24-hour care. Provision of appropriate long-term care services depends on matching of available resources with the individual's need for 24-hour care and/or skilled nursing care, personal care, or supportive care.

Ideally, a wide range of long-term care services would be available in each community, and elderly individuals could select the services they need. In fact, some services are not available in certain jurisdictions, and some are available only to those able to pay privately. Even when services are available in the community, it is often difficult for the elderly and their families to find out about them. Physicians and other health care professionals are frequently unaware of available services (24). Decisions about long-term care are often made in an atmosphere of crisis that is compounded by lack of information about available resources and lack of coordination of long-term care services at the community level.

NURSING HOMES

At present, there are approximately 20,000 nursing homes in the United States, providing beds for about 1.5 million residents, about 85 percent of whom are elderly. About 5 percent of those over 65 are residing in nursing homes at any one time. This number includes less than 2 percent of those 65 to 74, but more than 20 percent of those over 85 (125).

Nursing homes provide 24-hour care, skilled nursing services, and personal care in an institutional setting. Care is given by nurses or by nursing assistants supervised by nurses with written orders from a physician. In addition to skilled nursing care and personal care, nursing homes provide a type of sheltered housing, including room and board, housekeeping, and meal service, and 24-hour supervision. For some patients, this combination of sheltered housing, supportive services, and 24-hour supervision is more important than any specific nursing services available in the facility.

Funding for Nursing Home Care.—More than half the cost of nursing home care is funded by government programs, primarily Medicaid. As figure 22 illustrates, the remaining 47 percent is paid by patients and their families (45 percent) and by private insurance (less than 2 percent).

Residents.—Nursing home residents are most often admitted on the basis of medical diagnosis and need for nursing care. According to the National Nursing Home Survey, primary diagnoses on admission include cardiovascular diseases (40 percent), mental disorders such as senile psychosis, chronic brain syndrome, senility, mental retardation, and alcoholism (20 percent), diabetes (6 percent), arthritis and rheumatism (4 percent), hip fracture (2 percent), cancer (2 percent), and other (26 percent). Functional impairments are seldom formally evaluated on admission, but the survey indicates that most nursing home residents need assistance with basic physical activities (see fig. 23). More than 20 percent of nursing home residents required help with all six activities (128).[8] A comparison of nursing home residents and disabled elderly individuals in the community shows that three characteristics strongly predict nursing home placement: 1) dependency in toileting or eating, 2) dependency in bathing and dressing, and 3) mental disorders (138).

Nursing home residents are not a homogeneous group. They include: 1) terminally ill patients who have been discharged from a hospital because no further hospital care is needed; 2) individuals admitted from a hospital for recuperation and rehabilitation following surgery or a fracture; and 3) individuals who are medically stable but functionally impaired, due to chronic physical or mental conditions. About one-third to one-half of nursing home residents are discharged within 3 months (51,65); these tend to be individuals who have been admitted from a hospital with a diagnosis of cancer, stroke, or hip fracture. A 1981 study indicates that about one-half of these short-stay patients died either in the nursing home or in the hospital shortly after discharge from the nursing home; 41 percent returned home, and 13 percent were transferred to another health care facility. In contrast, individuals who stay longer in the nursing home are more often admitted from home and include a higher propor-

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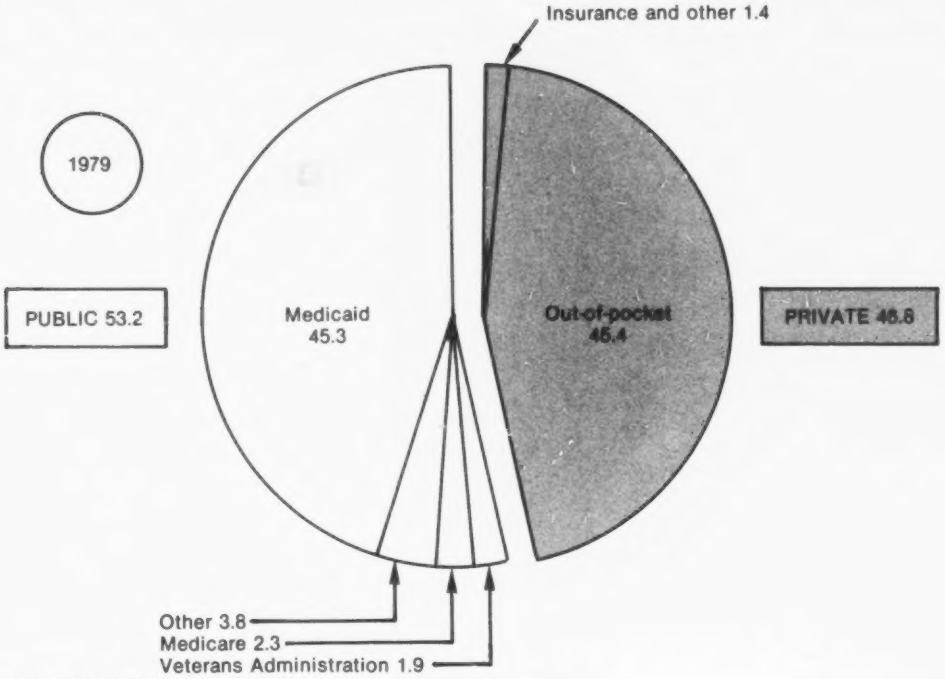
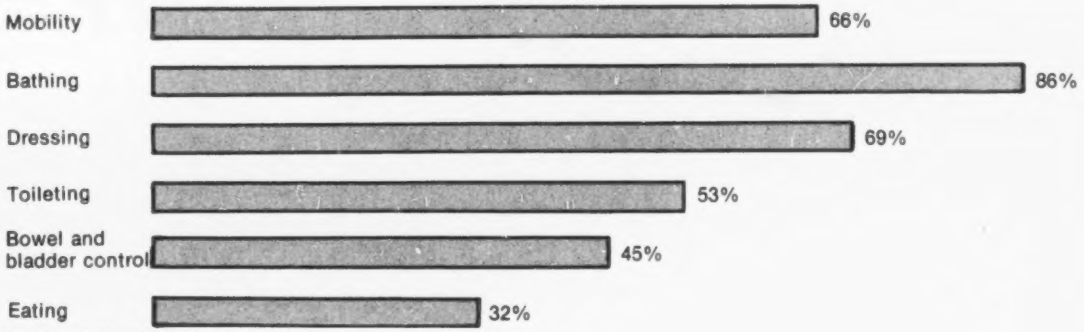
[8] Some evidence suggests that nursing home residents are now more dependent and more functionally impaired than in the past (119). This trend will accelerate as hospitals discharge sicker patients to nursing homes in response to the Medicare prospective payment system. Results of the 1985 National Nursing Home Survey can be expected to document this change.

Figure 22.—Percentage Distribution of Nursing Home Expenditures in the United States, 1979



SOURCE: GAO, 1983 (119).

Figure 23.—Percent of Nursing Home Residents Who Need Assistance With Basic Physical Activities: United States, 1977



SOURCE: DHHS, 1981 (128).

Photo credit: Gretchen Kolsrud

Many nursing home residents are medically stable, but require long-term care because of functional impairments.

tion of those with mental disorders; one-fourth of long-stayers had a primary diagnosis of mental disorder or senility compared with only 3 percent of short-stayers (51). These long-stay patients constitute the largest proportion of nursing home residents at any particular time.

Different subgroups of nursing home residents need different types of care and different technologies for appropriate treatment. For example, terminally ill patients might be best cared for with methods based on the hospice model, which emphasizes pain-control technologies and emotional support systems; individuals admitted for rehabilitation need assistive devices, physical and occupational therapies, and effective linkage with community agencies for continued care following discharge. Among the long-stay patients, appropriate technologies depend partly on the mental status of the patient; for mentally competent patients, technologies to maintain or improve physical functioning are appropriate. For those who are mentally impaired, environmental design technologies, cognitive therapies, and technologies to maintain physical health are more appropriate. For the new group of patients who are discharged early from hospitals as a result of the Medicare prospective reimbursement system, apppropriate technologies may be monitoring equipment and nursing care systems now used primarily in hospitals.

Some nursing homes provide technologies and systems of care appropriate to the different needs of unique subgroups of patients, but many nursing homes provide a relatively uniform system of care for all patients. This is due partly to lack of comprehensive assessment procedures to identify individual needs and partly to insufficient staff to provide individualized systems of care. Professional nurses who are trained to assess patient needs and plan individualized treatment are often in short supply in nursing homes and also perform many other functions in the facility, such as skilled medical treatments, supervision of largely untrained nursing aides, and time-consuming recordkeeping required by Federal and State regulations.

Recent research that identifies subgroups of nursing home residents (47,51,62,63,64,65,66) provides a strong knowledge base for defining distinct care needs of these subgroups, but this research is based on retrospective analysis, and it is not known how effectively nursing home patients can be identified as belonging to one subgroup or another at the time of admission. In addition, there is no consensus about whether patients with similar needs are best cared for in separate facilities, separate sections of the same facility, or mixed in with other kinds of patients as they usually are now. Further research is needed to clarify these issues.

Research on care systems designed for confused patients is particularly needed. Although about 50 percent of all nursing home residents have symptoms of mental impairment and some nursing home residents have longstanding emotional and behavioral problems, such as psychiatric conditions, alcoholism, and drug abuse, most nursing homes are not structured or staffed to meet the needs of these patients (95). Within the existing care system, mentally and emotionally impaired patients require more staff time than physically impaired patients (39,128). Some care providers believe these patients can be more easily and effectively cared for in a setting designed specifically to meet their needs.

Research on appropriate patterns of care for nursing home residents is currently funded through two Teaching Nursing Home Programs, one sponsored by the National Institute on Aging (NIA) and the other sponsored by the Robert Wood Johnson Foundation. NIA has awarded grants to five programs, each emphasizing treatment of specific disease conditions or functional impairments (124). The Robert Wood Johnson program is sponsoring affiliations between 11 nursing schools and local nursing homes (23). In addition to these programs, a few long-term care facilities have received public and private funding for the development of model nursing home services (58). Objectives of all these programs include investigation of disease processes in the elderly, evaluation of functional assessment measures, and development of treatment approaches.[9] Training opportunities for physicians, nurses, social workers, and other caregivers are provided. As these programs develop, models of care for specific subgroups of patients will be developed and refined.

BOARD AND CARE FACILITIES

Board and care facilities include a wide range of residences that provide room and board and some degree of protective supervision on a 24-hour basis. Unlike nursing homes, these facilities are not considered medical care institutions. Nursing care is generally not provided, but residents may receive assistance with some personal care activities such as bathing or dressing. Supportive services, such as cooking, cleaning, and laundry are also provided. Although board and care residents may have private rooms, they generally do not have private apartments because of the need for 24-hour supervision.

There are now about 30,000 board and care facilities in the United States, serving about 350,000 individuals, including elderly, mentally retarded, and mentally ill residents. Although no exact figures are available, it is estimated that about one-third to one-half of board and care residents are elderly. (Some of the elderly are mentally retarded and mentally ill, and some of those who are classified as mentally ill or mentally retarded are over 65.) Board and care facilities range in size from small adult foster homes and group homes to large residential care facilities and some retirement homes. Each State recognizes and licenses certain types of board and care facilities; although each State has some unlicensed board and care facilities, a recent study shows that 85 percent of all facilities are licensed (88).

Funding for Board and Care.—About one-third of residents pay privately for care. Among the other two-thirds, many receive Federal Supplemental Security Income (SSI) payments and use this income to pay for their care. In addition, States are allowed to supplement the Federal minimum SSI benefits, and by 1983, 34 States and the District of Columbia provided supplements for persons living in board and care facilities (52,131).

Residents.—Although very little information is available about the characteristics of elderly residents of board and care facilities, a recent study of residents of these facilities in seven States indicates that some residents needed assistance with basic self-care activities, such as bathing (26 percent), dressing (11 percent), walking (9 percent), and using the toilet (4 percent). Larger percentages of residents needed assistance with home management activities such as laundry (64 percent), cleaning, (55 percent), managing money (46 percent), shopping (43 percent), and taking medicine (43 percent). Chronic physical conditions of residents included degenerative joint diseases (36 percent), circulatory and heart disorders (25 percent), hearing impairments (22 percent), and respiratory diseases (14 percent). Perhaps more significant is the large percentage of residents with mental impairments. The researchers found that about 40 percent of the residents were mentally ill, disoriented, or exhibited memory impairment.[10] About 28 percent of the residents had previously resided in an institution for the mentally ill, while 21 percent had lived in a nursing home (31).

These data reflect a seriously disabled population with extensive physical and mental impairments. While no research is available to verify the primary reasons that residents need board and care services, it is likely that the high prevalence of mental illness, disorientation, and memory impairment explains much of the need for care. These confused and mentally ill residents are more likely to require supervision and assistance with laundry, cleaning, managing money, and taking medicine rather than personal care such as bathing, dressing, and walking. (It is interesting to note that the study did not find any residents who were incontinent or needed assistance with eating, the two primary risk factors for nursing home placement.)

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[9] Treatment goals include rehabilitation and discharge of some patients and lifelong supportive care for others.

[10] One-third of residents were assessed as mentally ill. Another one-third of residents were disoriented or exhibited mental impairment. These two groups overlapped, and one of the researchers has estimated that 40 percent of all residents were in one or both subgroups (104).

The cost of board and care facilities varies widely but is generally one-third to one-half the cost of nursing home care. Despite this relatively low cost, several problems limit demand for board and care homes; these include the generally poor reputation of these kinds of facilities[11] and lack of available information about the facilities, the services offered, and the cost of care. In addition, the pervasive emphasis on medical v. nonmedical forms of care in our society and the availability of Medicaid funding for nursing home care but not board and care limit demand for these facilities. The major factor restricting the supply of board and care homes is the low levels of reimbursement for providers (88).

Since the cost of care in most board and care facilities is substantially less than nursing home care, it is important to consider whether some nursing home residents could be cared for in board and care facilities. Both settings provide 24-hour supervision, and while some nursing home residents need skilled nursing care that is not available in board and care facilities, many actually receive little or no skilled nursing care. For these individuals, many of whom are the long-stay patients discussed earlier, board and care homes might provide a long-term care option that is cheaper and less personally restrictive than living for many years in a nursing home.

Technologies appropriate for the board and care population include:

- assessment technologies to identify individuals who can be best served in these kinds of facilities;
- assistive devices to improve the physical functioning of residents; and
- technologies for caregivers, including devices and care methods appropriate for mentally impaired residents.

In addition, improved information systems are needed to increase awareness of this long-term care option among the elderly, their families, and health care providers.

HOME CARE

Long-term care services provided in the home include medical, social, and supportive services designed to maintain the individual in the community and compensate for impaired functioning. Most medical and social services that are available in nursing homes can also be provided to individuals at home, but three problems restrict the use of these services: 1) lack of home care services in some communities, 2) lack of coordination of home care services in many communities, and 3) limited public funding for supportive services in the home. In this section, home care services are defined, and appropriate use of home care services is discussed. Because much attention has been focused on whether the availability of home care services can decrease the use of nursing homes, this question is also discussed.

Funding for Home Care Services.—Public funding for home care services is provided through Medicare, Medicaid, the VA, the Title XX Block Grant, and Title III of the Older Americans Act. Medicare and Medicaid fund primarily health care services, and complex regulations govern the kinds of services that are reimbursed. The Title XX Block Grant and Title III of the Older Americans Act fund primarily supportive services (see the technical memorandum at the conclusion of this chapter). Private insurance pays for some skilled nursing, physical therapy, and speech therapy provided in the home. Individuals and families also pay privately for home care services, but since these services are purchased independently from both agencies and individuals, little information is available about the kinds and cost of services used.

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[11] The American Bar Association has recently finalized a model State statute for board and care facilities that includes standards for physical environment, staff qualifications, resident rights, and administrative sanctions for noncompliance.

Clients.—Home care services are listed in table 15. The kinds of elderly individuals who use home care can be inferred from the wide variety of services that are available. Some patients have been recently discharged from the hospital and require nursing care and supervision of medical treatments. In fact, increasingly complex and sophisticated medical treatments, such as intravenous fluid replacement, antibiotic therapy, chemotherapy, enteral and parenteral nutrition, hemodialysis, and continuous ambulatory peritoneal dialysis, can now be provided in the home. Other patients need rehabilitation services such as physical or speech therapy that may have been started in the hospital but can continue in the home. Supportive services such as home delivered meals, homemaker, and chore services may be needed by the same individuals who need skilled nursing care or rehabilitative services and also by another large group of individuals with functional impairments that restrict their ability to shop, cook, or care for their homes.

Table 15.—Elements of Long-Term Care in the Home

Skilled nursing care: Medically oriented care provided by a licensed nurse to include monitoring of acute and unstable chronic medical conditions, evaluation of the patient's care needs, injections, care of wounds and bed sores, tube feedings, and clearing of air passages. Skilled nursing care is usually authorized by a physician.

Physical therapy: Rehabilitative therapy provided by a qualified physical therapist.

Speech therapy: Therapy provided by a qualified speech therapist to improve or restore speech.

Occupational therapy: Therapy provided by a qualified occupation therapist to improve functional abilities.

Medical social services: Assessment, referral, and counseling services related to the medical care needs of the patient.

Home health aide services: Assistance with simple, health-related tasks, such as medications and exercises, and personal care services provided under the supervision of a licensed nurse.

Personal care: Assistance with basic self-care activities such as bathing, dressing, getting out of bed, eating, and using the bathroom.

Homemaker services: Household services such as cooking, cleaning, laundry, shopping, and escort service.

Chore services: Household repairs, yard work, and errands.

Home-delivered meals: Meals delivered to the home for individuals who are unable to shop and/or cook for themselves.

Telephone reassurance: Regular telephone contact to individuals who are isolated and often homebound.

SOURCE: Office of Technology Assessment.

Home Care Services as a Substitute for Nursing Home Care.—It has been believed for many years that home care services could help to maintain impaired elderly individuals in their homes and avoid nursing home placement. Although this belief offers the hope of cost savings and has been used as an argument for increasing home care services, a recent GAO study of demonstration programs offering expanded home care services found that these services did not reduce utilization of nursing homes. GAO concluded:

> For some subpopulations of the elderly, providing home care services may decrease the use of nursing homes. However, more work, including the refinement of assessment tools, is needed to better define and identify individuals for whom nursing home use can be reasonably decreased (118).

The development and increased use of assessment technologies is discussed later in this chapter.

One reason that home care services do not reduce utilization of nursing homes is that many individuals who are at risk for nursing home placement need 24-hour care because they cannot be safely left alone or because they need assistance many times a day at widely separated time intervals. Formal home care services are seldom available on a 24-hour basis because of cost, and in many communities, publicly supported home care services are limited to only a few hours a day. As a result, if the individual lives alone or if no family member is available on a 24-hour basis, institutional care may be necessary.

As indicated in the example, formal home care services are not an appropriate long-term care option for elderly individuals who are too confused to remain safely alone and have no one to stay with them when the home care provider leaves. Increased use of comprehensive assessment technologies could help to identify individuals for whom board and care facility or a nursing home is a more appropriate long-term care option than home care.

Frantic calls were received at several nursing homes from a middle-aged man seeking a nursing home bed for his 73-year-old mother. She had little income, had broken her hip, and was

therefore eligible for Medicaid funding for nursing home care. She was living with her son, his wife, and their 13-year-old daughter, and the local home health agency was providing a home health aide 4 hours a day, 5 days a week to help with bathing and dressing the woman and providing the noon meal. Why was the son so frantic? Because his mother was confused and could not remember not to stand up on the broken hip. She had already fallen a second time. The son and his wife had each taken weeks off from work to stay home with her, and their jobs were in jeopardy, so the 13-year-old was staying home from school to make sure her grandmother didn't stand up and fall again. No home care agency in the area was able to provide more than 4 hours a day of publicly funded home care services, and the family could not afford to pay for the care that was needed.

Technologies in home care include:

- assessment technologies to identify patient needs and appropriate care methods;
- patient-care devices that have been used in hospitals but can be adapted for use in the home, and methods for teaching the elderly and their families to use these devices;
- assistive devices to decrease functional impairment, and techniques for training individuals to use these devices;
- environmental design technologies to accommodate the functional impairments of elderly individuals; and
- improved service delivery systems to increase awareness and appropriate access to home care services.

In addition, the information technologies discussed in chapter 6 could be used to meet some of the home care needs of the impaired elderly. For example, interactive television could be used to provide training in the use of devices and to answer questions about medical treatments provided in the home.

ADULT DAY CARE

Adult day care centers provide health and social services for impaired elderly individuals. Services vary among programs but frequently include supervision, personal care, group activities, meals, recreation, and exercise in addition to medical and medically related services such as physical therapy and speech therapy. Availability of these services in a centralized setting is convenient for both clients and health care providers (106). Two types of adult day care have been identified: 1) rehabilitation-oriented programs designed primarily to provide medical care and physical therapy, and 2) multipurpose programs designed to provide social stimulation for impaired and isolated elderly individuals and respite for the families who have been caring for them (137). The number of adult day care facilities in the United States has increased from fewer than 20 in 1970 to between 700 and 800 at present (1).

Funding for Adult Day Care.—Clients and their families often pay for some or all of the cost of adult day care themselves. Adult day care is an optional Medicaid service; as of 1984, eight States were providing Medicaid reimbursement for adult day care (127). In addition, 35 States provided adult day care with title XX funds, and several States provide adult day care services through demonstration projects funded under the Medicaid waiver program (24). Medicare does not cover adult day care programs, although some medical and physical therapy services provided for adult day care clients are covered by Medicare.

Clients.—Several studies have examined the characteristics of adult day care clients. A 1976 study of four programs showed that 56 percent

Photo credit: Suburban Hospital, Adult Day Care Program, Bethesda, MD

Adult day care programs can provide socialization and group activities in addition to medically related services such as physical therapy.

of the participants were severely dependent in activities of daily living, requiring assistance in eating, transferring (moving from bed to chair and chair to bed), or toileting, or were incontinent; another 16 percent were moderately impaired, requiring assistance with bathing or dressing, but not eating, transferring, or toileting (106). Another study comparing clients at an adult day care center with residents of a nursing home and individuals living independently in an apartment facility for the elderly found that the day care clients were most disabled in physical health, mental health, and activities of daily living, while the residents of the nursing home were most limited in socioeconomic areas, such as informal social supports and financial resources (85). A third study found that day care clients were generally less impaired than nursing home residents, but of the 25 most impaired day care clients, only 2 were living alone (111). These findings suggest that adult day care can be an appropriate resource for severely impaired individuals as long as they have sufficient informal supports and financial resources to maintain themselves at home when they are not at the day care center.

Technologies appropriate for adult day care include assessment technologies to identify elderly individuals who could be cared for in these settings and information systems to increase awareness of this long-term care option among the elderly, their families, and other service providers.

Some adult day care programs are designed specifically for mentally impaired individuals, with emphasis on consistency in program and staff to limit daily changes that are confusing to clients and environmental design that allows maximum independence without compromising safety (95). Evaluation of the efficacy and cost of these programs is needed. Treatment methods for mentally impaired individuals that have been developed in adult day care settings may provide a model of care for these patients that can be used in other long-term care settings.

HOSPICE

Hospice programs provide supportive services for individuals with terminal illness. Hospice is a method of care, not a place, and hospice care can be provided in a hospital, nursing home, or in the patient's home. Services include nursing care, medical social services, homemaker, home health aide services, and counseling for the patient and the family. In addition, short-term inpatient care is often available for crises. The technology of pain control is central to the hospice concept, and emphasis is on quality of life rather than aggressive medical treatment and prolongation of life.

The first hospice was established in this country in 1973, and by 1983 there were an estimated 1,100 to 1,200 hospice programs in the United States (49). Medicare benefits have been available for hospice care since November 1, 1983. Up to 6 months of hospice care can be covered.

Because hospice care is believed to be less expensive than hospitalization, Medicare coverage of hospice care may result in cost savings (121), but some experts question whether these savings will materialize. A recent study compared terminal cancer patients treated in a hospital-based hospice program with those who received conventional care. Hospice patients reported more satisfaction with their care than conventional care patients, but the cost of hospice care was the same or greater than the cost of conventional care. No significant differences were found between the groups in survival time, pain symptoms, or days in the hospital. While the conventional care patients spent more days in nursing homes than hospice patients, the majority of both groups died in the hospital; only 3 percent of the hospice patients and 7 percent of the conventional care patients died at home. Although hospice programs are designed to decrease the number of invasive diagnostic and curative treatments, the data show little difference between the two groups on these variables (49). These results raise questions about the real differences between hospice care and conventional care. Further research is needed, including comparison of methods, costs, and outcomes in hospices based in different settings, such as hospitals, nursing homes, and home care agencies.

Hospice care is a resource for terminally ill patients currently being cared for in nursing homes or in the community. Identification of terminal patients can present a difficult diagnostic procedure for certain subpopulations, and the development of more precise guidelines and diagnostic criteria is needed. Improved service delivery technologies are also needed to make information about the hospice alternative available to appropriate patients and their families.

RESPITE CARE

Respite care is temporary care provided for the impaired elderly to relieve the primary caregivers. Respite care can be provided in nursing homes, board and care facilities, or in the individual's home, and can range from several hours up to a week or longer. Public funding for formal respite care programs is available in some communities through the Title XX Block Grant and Title III of the Older Americans Act. There is no Medicaid funding for respite care under the general program, but respite care is part of 15 of the 26 approved Medicaid 2176 waiver programs for the elderly (138). (See the technical memorandum at the end of this chapter for a description of the Medicaid 2176 waiver program.) In addition, home health care, personal care, and homemaker services funded through Medicare, Medicaid, Title XX, and Title III may be used by some families as respite care, since caregivers are able to leave the home when the aide or homemaker is present.

CONGREGATE HOUSING

Congregate housing for the elderly, which is discussed in chapter 9, is included here because the design features and supportive services available in some congregate housing facilities compensate for the functional impairments of elderly residents and thus postpone or avoid the need for other long-term care services. Physical design features such as emergency call buttons, grab-bars in the bathroom, and safety features on ovens have been built into many publicly and privately funded congregate housing facilities for the elderly. Some of these facilities also provide optional supportive services such as meals and housekeeping that can eliminate the need for shopping and some home management activities. Alarm systems in each apartment provide psychological security for physically impaired individuals. Opportunities for socialization and recreational activities in the facility can help to maintain emotional well-being.

Most congregate housing facilities in this country have been built within the past 20 years. Over time, administrators at these facilities have had to deal with the increasing physical and mental impairments of their aging residents. In some facilities, residents have been required or encouraged to move out when their functioning decreased below the level established for admission. In other facilities, these residents are not required to move, and in some facilities, increased services have been provided to help compensate for impairments and maintain independent functioning.

Both physical and mental impairments of residents can limit their ability to function adequately in congregate housing. Physical problems such as severe illness, the need for frequent monitoring of medication, and being bedridden interfere with the individual's ability to live independently, and residents with these problems usually transfer to other long-term care settings. Mental and emotional problems, incontinence, and accident proclivities are also seen as very disruptive by managers and other residents, but individuals with these problems often do not see the need to move (13), which can create difficult administrative problems for managers.

In summary, congregate housing is an appropriate long-term care option for some physically impaired individuals. The level and type of impairment that can be safely accommodated depends on the availability of supportive services and physical design features for the handicapped in each facility. Congregate housing is usually not an appropriate option for mentally impaired individuals because of the lack of 24-hour supervision. Federal policy initiatives to increase the availability of congregate housing and encourage provision of services for physically impaired residents are discussed in chapter 9.

Issues in long-term care settings and services

Several general issues related to long-term care services and settings are discussed in this section, including the comparative cost of care in various settings and the perception of settings as distinct caregiving systems.

COMPARATIVE COSTS OF CARE

Accurate comparison of the cost of various long-term care services is difficult because costs vary from one city to another and from rural to urban areas. Within communities, costs vary depending on the agency providing the service and the source of payment. For example, Medicare usually pays considerably more for specific services than Medicaid. Cost comparisons are further complicated by the inclusion of room and board in the cost of some long-term care services, such as nursing home care, but not in the cost of other services, such as home care and adult day care. Despite these difficulties, some generalizations can be made about relative costs of care.

In general, nursing home care costs more than other forms of care because the per diem rate is relatively high and most patients receive care for extended periods. Private patients usually pay the highest rate, followed by VA and Medicare patients, and then Medicaid patients. For calendar year 1979, the average per diem rate was $63.73 for VA patients, $38 for Medicare patients, and $23.59 for Medicaid patients (24). The cost of care in board and care facilities varies widely, but is generally one-third to one-half the cost of nursing home care. In early 1980, the average cost in board and care facilities was about $10 a day (88). In comparison, the average daily cost of hospital care was $226 in 1979 (120), and the average Medicare reimbursement for hospital care was $182 per day (126).

The cost of home care depends on the type of services provided and the source of payment. Medicare payments for home care are relatively high. Reimbursement guidelines for the year ending June 30, 1980, were: skilled nursing care, $41.80 (urban) and $38.05 (rural); home health aide visits, $33.00 (urban) and $27.70 (rural) (116). Medicaid payments for home care services are generally much lower. For example, in Colorado in 1980, one home care provider received $45 for a skilled nursing visit under Medicare but only $28 from Medicaid, and $10.24 for a home health aide visit under Medicare but $4 from Medicaid (117). In Washington, DC, in 1980, Medicaid paid $23.75 to $27.63 for skilled nursing visits, $8.61 to $10.50 per hour for personal care, and $2.90 per hour for homemaker services (117).[12] No information is available about the cost of home care services paid for by individuals.

These figures indicate that the Medicare rate for a single skilled nursing visit is similar to the Medicare rate for a day of nursing home care. Since the cost of home care does *not* include room and board and other living expenses, the overall cost of care for an individual who needs daily skilled nursing care at home can be higher than the cost of nursing home care. Most home care patients do not, however, require or receive daily skilled nursing visits; the nurse may go out once or twice a week or less, with intervening visits of a less expensive home health aide. Home care is thus usually less expensive than nursing home care. The Medicare reimbursement for a home health aide visit was about 75 to 85 percent of the Medicare reimbursement for a day of nursing home care, and also does not include the cost of room and board. The Medicaid payment for 1 hour of personal care in the home in Washington, DC, was about one-third to one-half the average per diem Medicaid payment for nursing home care nationwide.

The cost of adult day care varies according to the type of program. Those with a rehabilitation emphasis cost about twice as much as programs with a social emphasis, and some adult day care costs the same or more than nursing home care. A 1976 study of four adult day care programs with a rehabilitation emphasis showed that the average per diem cost was $52 a day, but with a wide range of $18.54 to $88.17 (106). Adult day care clients seldom attend every day, however. The same study found that average attendance was 70 days per person per year with a range of 48 to 114 days between the four sites (106). As a result, the overall monthly cost of adult day care is significantly less than nursing home care and may be similar to the cost of a board and care facility.

The cost of hospice care and respite care depends on the kinds of services used and the frequency of utilization. At present, Medicare reimbursement for hospice care is limited to $53.17 a day for a maximum of 6 months.

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[12] It is likely that the lower Medicaid reimbursement rates discourage providers from serving Medicaid recipients.

Congregate housing is considerably less expensive than other long-term care services. In federally subsidized housing, residents who are eligible for section 8 subsidies pay 30 percent of their income for rent. Monthly rent for other elderly individuals can range from $400 per month up to $1,200 to $1,500 or more, depending on the facility and the amenities provided.

A recent study focused on costs and outcomes for individuals receiving services in four settings—nursing homes, geriatric day hospitals (adult day care centers), board and care facilities, and senior centers. Applicants were screened and statistical methods were used to develop subgroups of similar individuals receiving services from each type of agency.[13] After 9 months, no consistent significant differences were found between subgroups on a wide variety of outcome measures, including utilization of skills for independent living, community integration, unmet service needs, and living conditions. There were, however, significant differences in the cost of care. Considering *total* expenses for individuals in each subgroup, the adult day care was most expensive (about $48 per day),[14] followed by nursing home (about $40 per day), senior center (about $34 per day), and board and care (about $31 per day). These figures include the costs of acute care services, formal and informal long-term care services, and living expenses in the community. When only the cost of formal long-term care services is calculated, the order is changed: nursing homes are slightly more expensive than adult day care and more than twice as expensive as board and care facilities, while senior center services were least expensive (102).

Although these data were derived through a complex analysis of patients and services provided in a limited number of settings in Pennsylvania and Delaware, they raise important questions about the differences between services and costs of care in various long-term care settings.

SETTINGS AND SERVICES AS DISTINCT CAREGIVING SYSTEMS

Long-term care services are most frequently described using a model in which each of a variety of agencies provides unique services appropriate for specific subgroups of patients. Current funding mechanisms and most long-term care decision-making systems assume that this description represents reality. In this system, only those technologies appropriate to each subgroup of patients would be used in certain agencies.

An alternative model of long-term care includes many agencies, each providing a wide range of services to a broad mix of patients with a variety of needs. The discussion of long-term care settings and services in this chapter indicates that this model more accurately represents current reality. Increased use of technology in this model is more difficult and more expensive because many different kinds of technologies will be needed in each setting. For example, technologies that are appropriate for residents of a single nursing home could include hospice care techniques and pain-control technologies; a wide range of assistive devices and rehabilitation services, including physical, occupational, and speech therapy; technologies for caregivers; patient monitoring devices; and environmental design technologies. The cost of making these technologies available in the nursing home would be very high.

The question of whether it is more effective to provide a unique set of services in each setting or a wide range of services to a variety of patients depends not only on the relative costs of increasing the use of technology. It also depends on the feasibility of dividing patients into subgroups and the impact on patient morale and quality of care of moving patients when their needs change. Three questions relevant to these issues can be raised:

- Can available assessment measures effectively identify care needs for a large proportion of long-term care patients, including both the services the patient needs and those he does not need?

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[13] Many applicants to each agency were not included in this study because their needs and/or characteristics were different from those of individuals in the identified subgroups. The authors emphasize that their results are *only* applicable to the kinds of individuals they studied.

[14] The adult day care services discussed here were rehabilitation-oriented services provided in a hospital as opposed to socially oriented services that are much less costly.

- How frequently do the needs of individual patients change, resulting in the necessity for different services and technologies?
- What is the impact on patients of moving them when their needs change?

Anecdotal evidence suggests some negative effects of moving patients, including increased disorientation in a new setting and lowered morale as a result of separation from friends and a familiar setting. Balancing these negative effects against the positive aspects of receiving care in a setting uniquely structured to meet one's needs is an issue that requires further research. The relative ease and lower cost of increasing the use of technology in a long-term care system with each agency providing a unique set of services is only one factor in the decision about which model of long-term care services is most beneficial for patients.

Technologies in long-term care

Assessment technologies

Assessment technologies include both formal assessment measures used to evaluate the individual and knowledge about how and when to use these measures and how to evaluate the results. Effective assessment procedures are important both for good patient care and for sound public policy. Planning appropriate long-term care for a disabled elderly individual requires an understanding of the condition of the individual and the complex interaction of physical, mental, social, and environmental factors that result in functional impairment and create the need for long-term care services. Similarly, sound public policy decisions about the administration and financing of long-term care services require reliable and valid information about functional impairments and the need for services in the elderly population (140).

CURRENT USE

A large number of assessment measures have been developed over the past 25 years in the United States, and are being used in long-term care research, demonstration projects, and specialized geriatric assessment centers. Most of these measures emphasize the functional status of the individual, and some also assess social and environmental factors that affect the need for long-term care services. Experts in gerontology and long-term care agree that comprehensive functional assessment is essential for the evaluation of elderly individuals for long-term care purposes and that formal assessment measures are important tools for gathering the necessary information, yet most physicians and other long-term care service providers are not using these tools.

The failure of physicians and long-term care providers to use comprehensive assessment measures may be based in part on lack of knowledge about these technologies. Perhaps more important is the fact that Medicare and Medicaid eligibility for most long-term care services is not based on a comprehensive functional assessment of the patient, and no standard assessment is required for individuals who pay privately for long-term care services. Thus physicians and long-term care providers are not required to use comprehensive assessment measures and are often reluctant to spend the additional time needed to complete the assessment.

Failure to use comprehensive assessment measures can result in failure to identify treatable conditions. For example, a recent study of incontinence in nursing home patients (75) found that 50 percent of the residents were incontinent, but only 14 percent of these incontinent patients had this problem listed by their physicians, and very few were receiving any treatment for it. While identification of incontinence would result from a thorough medical evaluation, many nursing home residents do not receive thorough evaluations. Use of a comprehensive assessment measure by the physician or another health care professional could increase the probability of identifying these conditions.

Many research projects and demonstration programs have used comprehensive assessment measures to identify appropriate long-term care services for elderly individuals. For example, one study evaluated the use of comprehensive assessment for frail elderly individuals living at home and awaiting placement in a nursing home; as a result of the assessments, about 60 percent were recommended for and assisted in receiving long-term care outside a nursing home, including 23 percent who received supportive services at home, and 30 percent who were placed in supervised boarding homes (140). Other studies have demonstrated the use of comprehensive assessment measures for identification of inappropriate use of services and unmet needs in the community and for patient planning and treatment evaluation in nursing homes (38,48,140).

There is as yet no consensus on the validity of studies showing positive results of the use of comprehensive assessment measures. Some experts believe that the state of the art in assessment technology may not be sufficiently developed to provide positive results (17). One recent study indicates that the use of comprehensive assessment measures is effective in improving patient outcome only in certain groups of patients (91a). Ongoing research at specialized geriatric assessment centers around the country can be expected to clarify these questions.

ASSESSMENT MEASURES

Although an enormous number of variables are related to functional impairments and long-term care needs, it is generally agreed that the most important can be grouped in a few general categories or domains, including: 1) need for medical treatment, 2) physical functioning, 3) mental functioning, and 4) social functioning and environmental fit. In each category, evaluation of the residual strengths of the individual is as important for long-term care decisionmaking as the identification of deficits and problems. In the following sections, variables in each of the categories and problems with measurement are discussed.

Measurement of Need for Medical Treatment.—Most assessment instruments designed for impaired elderly individuals include an evaluation of specific medical care needs, such as the need for tracheostomy, respiratory therapy, or intravenous medications. The need for frequent physician services, skilled nursing care, physical therapy, occupational therapy, and speech therapy is also usually evaluated. This information is important because the availability of needed medical care services in the community and in long-term care institutions may affect appropriate placement of the individual. No problems in the assessment of information in this category have been noted (140).

Measurement of Physical Functioning.—Assessment instruments designed to evaluate physical functioning include measures of general physical health, such as bed days, restricted activity days, and predicted life expectancy; measures of self-care activities, such as bathing, dressing, and feeding; and measures of home management and independent functioning, such as shopping, cooking, using a telephone, taking medications, and managing money. Although many of the same activities are included in several measurement instruments, differences in wording and scales may mean that results using different instruments may not be comparable and some instruments may be more useful in certain settings than others (43).

Several conceptual problems in the measurement of physical functioning have been noted. First, the functional ability of elderly individuals is known to vary from day to day as a result of fatigue, acute illness, and other factors, making it difficult to arrive at a single measure of physical functioning. Second, both motivation and opportunity affect physical functioning (43), and there may be a need to distinguish between those who are unable to perform a certain function under any circumstances, those who are not motivated to perform the function, and those who do not have an opportunity to perform the function, such as nursing home residents who do not need to cook and often are not allowed to shower without assistance. Third, functional ability can sometimes be improved with the use of assistive devices, and assessment measures differ in the way that functioning with the use of an assistive device is handled (43).

Assessment measures have been used extensively in the National Long-Term Care Channeling Demonstration Program described later in this chapter. Preliminary findings on the use of these measures indicate several areas of physical functioning that are not adequately evaluated with available measures. These include: 1) deficits in vision, hearing, and speech that can have a major impact on the ability to function independently, 2) the relative ease or difficulty with which an individual performs a certain function, and 3) the individual's potential to perform a certain function in a different setting or with rehabilitation training (77). Each of these issues is important for the evaluation of an individual's need for long-term care services.

Measures of Mental Functioning.—Assessment instruments have been developed to measure three main aspects of mental functioning: cognitive functioning, affective functioning, and general mental health. Measures of cognitive functioning focus on orientation to person, place, and time; personal and current information; attention; comprehension; and memory. Measures of affective functioning focus primarily on depression, and measures of general mental health generally screen for psychiatric illnesses (43).

Valid assessment of mental functioning is even more difficult than assessment of physical functioning, partly because of problems in defining conditions such as "confusion," "dementia," "disorientation," and "depression" (84,140). In addition, mental functioning in the elderly is often affected by acute and chronic illnesses and by medications prescribed for these illnesses (43); as these physical factors change from day to day, mental functioning may also change. It is also difficult to separate cognitive impairment from depression since some depressions have symptoms like dementia in the elderly (43). For these reasons, the reliability and validity of measures of mental functioning have been difficult to establish. It has been suggested that the available measures of mental functioning should be used only as gross screening tools for identifying individuals who need more intensive evaluation (140).

A major problem in using measures of mental functioning in long-term care is that the relationship between impaired mental function and a need for long-term care services has not been established. It is known that some individuals with considerable memory problems are able to function safely in their familiar home environment, while others who perform well on tests of memory may be subject to occasional or continuous confusion or agitation that limits their ability to function independently (140).

Some recent research indicates that severity of functional impairment may be related to the loss of specific cognitive functions. One study suggests that individuals with primary losses in memory and orientation had less severe functional impairment, while those with primary losses in attention and recognition were more severely impaired (133). Commonly used mental status measures that emphasize memory and orientation may therefore *not* distinguish accurately between those who are able to care for themselves and those who need assistance with self-care as a result of mental impairment (142). Increased understanding of the relationship between loss of specific cognitive functions and the need for long-term care services is important for identifying individuals who need care, designing appropriate care systems, and estimating the future size of the long-term care population.

Measurement of Social Functioning and Environmental Fit.—Evaluation of social and environmental functions affecting the impaired individual is important for decisionmaking in long-term care (43,140). Informal support provided by family and friends often allows mentally and physically impaired individuals to remain at home rather than be placed in a nursing home. Similarly, the characteristics of the individual's environment, including the physical layout and any rules, regulations, or external constraints will often affect his well-being and his ability to function independently (43).

Despite the recognized importance of social supports and environmental characteristics for the impaired elderly, it has been difficult to develop valid assessment tools to measure these factors. Although the general concepts of social functioning, social supports, and environmental fit are clearly related to long-term care needs, it is difficult to specify the aspects of these concepts that are most relevant to long-term care decisionmaking. In addition, interpretation of results is complicated by lack of norms and by important differences in the way that individuals react to social

Photo credit: Marjory Collins

Many kinds of emotional and social support are related to long-term care needs.

and environmental realities (12,43). For example, some individuals may be satisfied with much less social interaction and fewer social activities than others. Similarly, rules and environmental constraints that are experienced as very restrictive by some individuals may have a neutral or positive effect on others. Objective measurement of the complex interaction between the individual's preferences and expectations and the reality of his physical and social environment is difficult.

Kane and Kane (43) have discussed measurement tools in three categories: social interactions and resources, personal coping and subjective well-being, and environmental fit. Some measures in each of these categories have been developed for use in long-term care decisionmaking, while others were designed for use with the well elderly or for individuals of all ages. Measures of social interactions and resources generally include items about the existence and location of family and friends, frequency and quality of intergenerational contacts, and other social activities. Measures of personal coping and subjective well-being include scales on life satisfaction, morale, happiness, adaptability, and coping skills. The third category, environmental fit, includes measures to describe the individual's environment, rules, regulations, and programmatic aspects of his living situation, and the fit between his characteristics and aspects of his environment.

Multidimensional Measures.—Multidimensional assessment measures are designed to provide information about many different aspects of client functioning, including physical, mental, social, and environmental. Examples include: the Sickness Impact Profile (SIP), developed to assess the outcome of health care; the Older Americans Resources and Services instrument (OARS), developed at Duke University and used in a GAO study in Cleveland, OH; the Comprehensive Assessment and Referral Evaluation (CARE), developed for the United States-United Kingdom Cross-National Project; and the Patient Appraisal and Care Evaluation (PACE), developed by four universities for use in the management of patients and for administrative and research purposes (43).

Issues of reliability and validity have been particularly troublesome with multidisciplinary measures, particularly questions about inter-rater reliability and how to evaluate the validity of these measures. Several general issues affecting the use of multidisciplinary measures and all geriatric assessment technologies are discussed here.

ISSUES IN ASSESSMENT TECHNOLOGY

Which Instrument to Use.—The large number of available assessment tools presents a difficult choice for geriatric practitioners. Many of these measures have been developed for research or demonstration projects. Measures developed for research and demonstration programs are often too long to be practical for widespread use by geriatric practitioners.[15] In addition, researchers have often devised new instruments or adapted existing instruments to precisely serve the purpose of their projects; this increases the number of available instruments and does not help to test the validity or reliability of existing measures (20).

Assessment can serve a variety of purposes, including description, screening, diagnostic and treatment planning, monitoring changes, and predicting outcome; certain assessment measures are believed to be more appropriate for one purpose than another (43). A concise pamphlet for practitioners on available assessment tools and appropriate uses is needed.

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[15] It has been estimated that under the existing payment structure family physicians, general practitioners, and internists cannot be expected to spend longer than 5 additional minutes in assessment of their elderly patients (45).

Incentives for Use.—As described earlier, there is little incentive for widespread use of assessment measures. Comprehensive functional assessment is generally not required for public funding of long-term care services, and neither Medicare nor Medicaid provide reimbursement for the physician's time spent in functional assessment. Required use of a comprehensive functional assessment measure as part of eligibility determination for publicly funded long-term care services would create an incentive for use of these measures. A 1977 report by the Institute of Medicine has recommended this approach:

> The Federal Government should reimburse for long-term care provided to the functionally dependent elderly . . . Eligibility for Federal reimbursement of long-term care should be based on a comprehensive assessment process (41).

Functional assessment is "recommended to serve a 'gatekeeper' function for long-term care services as well as to assure appropriateness of care for the individual patient" (41).

Selection or development of a comprehensive functional assessment instrument for determining eligibility for publicly funded long-term care services would require choices about the most important factors to measure and the most appropriate structure and wording for the test instrument. The required use of such an instrument would, however, eliminate uncertainty about which one to use, and repeated use of the same instrument would allow for extensive evaluation of reliability and validity and subsequent refinement of the instrument.

Physicians and other long-term care providers now spend considerable time on forms to establish eligibility of patients and clients for publicly funded long-term care services. A comprehensive functional assessment measure might be substituted for other currently required forms. Since public funds pay such a large proportion of long-term care services, agencies required to use an assessment measure for publicly funded services might gradually extend the use of this measure to privately funded services as well.

The Value of Scoring.—Some assessment measures result in numerical scores on individual sections or an overall score on all sections of the test. These scores are used to indicate degree of impairment in physical or mental functioning, or the extent and kind of services needed, and can also be used to measure improvement or deterioration in an individual patient. In some States, scores on comprehensive assessment measures are used to determine eligibility for certain long-term care services; for example, in New York State elderly individuals who score over 180 on a comprehensive functional assessment measure are eligible for Medicaid-funded nursing home placement (140).

Although scoring has been used extensively for research and administrative purposes, there is great concern about the validity of this process. Little information is available about the relative importance of various aspects of functioning. It has been pointed out that these scoring systems often assume that "the items being scored consist of a systematic, ordinal set of characteristics of a single phenomenon (e.g., total physical functional disability, total mental disability, total physical plus mental disability, etc.) (140). In fact:

> The items being scored are rarely if ever of an ordinal nature, (and) there is no basis for assuming an ordinal relationship (between items) in which a given score would represent a given degree of total mental function and a specific higher score would represent a predictably proportionately better level of total mental functioning (140).

The use of overall scores for the evaluation of an individual patient tends to obscure information about specific problem areas, but scores on selected test items can be used the way the results of lab tests are used, to indicate the presence or absence of a problem that requires further analysis (140).

Who Should Do the Assessment.—Comprehensive functional assessment involves two steps: collection of the necessary information and analysis of the information. Each of these procedures can and is being done in various settings by individuals with or without special training in geriatric assessment, by physicians, social workers, or nurses, and by teams of health care professionals, each collecting and analyzing information in his area of expertise. Information can also be collected and analyzed by computer. The decision about who should do the assessment depends on numerous factors that interact:

- the purpose of the assessment,
- availability of funding for collection and analysis of the information,
- availability of trained staff to do the assessments,
- degree of confidence in the reliability and validity of the assessment instrument, and
- beliefs about the role and importance of clinical judgment in the collection and analysis of the information.

Some experts have suggested that since many physicians have been reluctant to spend the time needed for comprehensive assessment, these assessments should be available through geriatric assessment centers in local jurisdictions. At present, comprehensive functional assessment measures are sometimes used for research and administrative purposes without the additional evaluation of a trained professional, yet it is generally believed that adequate patient care and long-term care planning require clinical judgment. In fact, some experts believe that assessment measures should only be used as general screening tools to identify individuals who need further evaluation by trained professionals. Others believe that formal assessment tools are not needed for patient care when a trained professional is available to evaluate the patient; even in this case, however, assessment measures can help remind the clinician of important factors to evaluate. In addition, the common language of the assessment measure provides a method for teaching geriatric care and communicating between disciplines (91).

The role of the patient and his preferences has received relatively little attention in discussions of comprehensive assessment measures. Since patient motivation and expectations are known to affect response to chronic disease and impairments, this issue needs more attention. In this context, adequate procedures for maintaining confidentiality of patient records are especially important since information about all aspects of the patient's functioning is available on the assessment form.

Assistive devices and rehabilitation techniques

Technologies to maintain or increase the independence of the elderly include assistive devices and rehabilitation techniques that compensate for functional impairment. For some individuals the appropriate use of these technologies will postpone or eliminate the need for institutionalization or extensive home care services; for others the use of assistive devices and rehabilitation techniques can reduce the burden of care on family and friends. In nursing homes and board and care facilities, these technologies can improve the quality of life for residents by maintaining some level of independent functioning and decreasing the need for staff assistance.

The goal of rehabilitation is to maintain or restore independent functioning, rather than to cure disease. For the elderly, this approach is particularly important because many of the diseases that affect the elderly are not curable at present. Rehabilitation technologies can help an individual to function independently despite underlying disease conditions. Even relatively small improvements in functioning can make a difference in self-care ability. For example, a stroke victim who can learn to transfer from bed to wheelchair and wheelchair to commode can be independent in many self-care activities (140). Similarly, an individual with severe tremor due to Parkinson's disease can continue to feed himself using devices such as splints and special eating utensils, thus avoiding the need to be fed and associated feelings of dependence and loss of control.

REHABILITATION TECHNOLOGIES

Many assistive devices have been developed to compensate for functional impairment. They range from such simple devices as a long-handled soaper to help an individual with limited arm motion to bathe himself to such highly sophisticated devices as voice-controlled robots for bedridden patients that are being developed by the Veterans Administration/Stanford University Robotic Aid Project (32). Some examples of assistive devices to compensate for common impairments of the elderly are shown in table 16.

Sources of information about assistive devices include computerized data systems and catalogs produced by public agencies and private manufacturing and retail companies. ABLEDATA, a computerized data base sponsored by the National Institute for Handicapped Research, currently lists more than 6,000 products for disabled

Table 16.—Examples of Assistive Devices for the Functionally Impaired Elderly[a]

Impairment	Simple devices	Complex devices
Vision	Lighted magnifying glass Large-print books	Electronic reading machine that converts printed material to speech
Hearing	Hand-held speaking tube or horn	Infrared hearing system that transforms an audio signal via infrared light beam to a receiver worn by the listener, thus suppressing background noise that is a problem for hearing aid users (57)
Speech	Manual communication board; the individual points to a symbol or what he wants to say	Electronic communication board with memory and print-out capability. The individual uses a switch to activate a cursor on the board to indicate words or messages (19). Portable speech synthesizer (8)
Memory	Pad to keep notes for reminders	Clock radio system that verbalizes reminders and automatically controls some appliances
Mobility	Braces and splints	Computerized electrical impulse device to stimulate muscles and allow paralyzed persons to walk (40)
	Canes, walkers, and wheelchairs	Voice-controlled, electric wheelchair that can open doors and manipulate switches (8)
	Ramps	Electric chairlift for stairs
Upper extremity weakness	Reachers and grippers Levers to facilitate turning door knobs and faucet handles	Prosthetic control system using electronic sensors and mechanical transducers to operate a prosthetic arm (8)
Bathing	Shower or bathtub chair	Hydraulic bath lift
	Long-handled soaper	Horizontal shower (19)
Dressing	Velcro fasteners Clothing that opens in front	No complex devices known
Eating	Utensils with built-up handles	Automatic feeding machine (56)
Toileting	Bedside commode	Commode with automatic toilet flusher, warm water bidet and hot air drying in a push-button unit (19)
Shopping	Shopping cart for a wheelchair user Prepackaged, freeze-dried meals	Shopping by computer
Cooking	Suction gripper to hold a jar to be opened	Robot that can prepare meals (56)
Environmental control	Switches and controls on extension cords that can be reached by the patient	Computerized remote environmental control system to allow a bed or chair-bound patient to adjust lights, radios, TVs, thermostats, and other electrically controlled appliances (19)

[a] These devices were selected to illustrate the kinds of assistive devices that are available. Thousands of other devices are also available.

SOURCE: Office of Technology Assessment.

persons of all ages. Other computerized data systems include "Accent on Information," a proprietary system developed by Raymond Cheevers, and "Automated Retrieval of Information on Assistive Devices" (ARIAD), developed and maintained by Louisiana Tech University (108). Several catalogs list assistive devices for the elderly. For example, *A Catalogue of Products and Services To Enhance the Independence of the Elderly*, compiled at Drexel University, lists more than 250 products, including appliances, special clothing, and communications devices (5). The American Association of Retired Persons and the Western Gerontological Society are completing a catalog of about 400 devices that assist older persons to live independently at home. The catalog will be published in early 1985 (54).

In addition to assistive devices, many rehabilitation techniques are used by physiatrists (physicians who specialize in rehabilitation), physical therapists, occupational therapists, nurses, and other health care professionals to assist disabled persons to maintain or improve their functioning. Rehabilitation techniques are included in this section with assistive devices because they are alternative technologies for maintaining independence and because the effective use of assistive devices often depends on the simultaneous availability of rehabilitation services and procedures (55). Like assistive devices, rehabilitation techniques can be simple procedures such as teaching a stroke victim and his family how to lay out his clothes to allow him maximum independence in dressing, or complex procedures such as the use of electronic sensing devices to provide biofeedback to a disabled person who is not able to sense the position of his feet or arms.

Appropriate rehabilitation technology for any individual depends on an evaluation of functional impairments and residual function; that is, which functions the individual is not able to perform and which abilities and functions he retains. Assessment of the individual should determine the need for a simple device or a more complex one. Often both a device and rehabilitation services are needed. For example, a person with degenerative joint disease may need both a cane or walker and physical therapy in order to maintain mobility. Successful use of rehabilitation technologies depends as much or more on matching the individual and the appropriate technology as it does on the existence of sophisticated devices and rehabilitation techniques (26).[16]

CURRENT FEDERAL INVOLVEMENT IN RESEARCH AND DELIVERY OF REHABILITATION TECHNOLOGIES

Many Federal Government agencies have programs of research, evaluation, or funding of rehabilitation technologies. Most of these are directed toward the needs of disabled individuals of all ages and focus on certain types of devices, a particular step in the process of designing and evaluating devices, or provision of devices and rehabilitation services to individuals.

The National Institute of Handicapped Research (NIHR)[17] is the lead agency responsible for initiating, funding, and coordinating Federal research to benefit disabled persons of all ages. NIHR's long-range plan, submitted to Congress in January 1981, included recognition of the special needs of the disabled elderly and a commitment to relevant research. NIHR currently funds 21 Rehabilitation Research and Training Centers, including two focused specifically on the needs of the elderly: one at the University of Pennsylvania and the other at Rancho Los Amigos Rehabilitation Hospital, in affiliation with the Ethel Percy Andrus Gerontology Center and the School of Medicine of the University of Southern California (122,135).

Federal funding for some assistive devices and rehabilitation services for the elderly is available through Medicare and Medicaid, and to a limited extent through State rehabilitation agencies supported in part by grants from the Rehabilitation Services Administration. The VA is a major provider of assistive devices and rehabilitation services for disabled veterans of all ages and is the Nation's largest purchaser of assistive devices (69).

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[16] There is continuing debate about how to allocate research and delivery resources between simple, relatively inexpensive devices and technologically sophisticated devices. This debate at a policy level tends to focus more on devices than on the needs of the individual (34).

[17] NIHR was created by the Rehabilitation, Comprehensive Services, and Developmental Disabilities Amendments of 1978 (Public Law 95-602) which moved the existing research programs of the Rehabilitation Services Administration in the Department of Health, Education, and Welfare (now, the Department of Health and Human Services) to the Office of Special Education in the Department of Education.

The VA funds research in rehabilitation technology for disabled persons of all ages through its Rehabilitation Engineering Research and Development Program (122).

FACTORS AFFECTING THE USE OF REHABILITATION TECHNOLOGIES BY THE ELDERLY

Despite the availability of thousands of assistive devices and rehabilitation techniques, several problems limit the use of these technologies by the elderly:

- The elderly often have several functional impairments associated with multiple chronic diseases. Devices and techniques appropriate for one impairment may not be usable because of other impairments the individual has.
- Cognitive impairment can interfere with an elderly individual's ability to use an assistive device or respond to a rehabilitation technique.
- Negative stereotypes about the elderly and their potential for rehabilitation limit the interest and enthusiasm of rehabilitation specialists, and sometimes the elderly and their families, for obtaining and using rehabilitation technologies.
- Limited availability of skilled rehabilitation personnel in long-term care settings restricts access to assistive devices and rehabilitation services.

Other problems limit the use of rehabilitation technologies by disabled persons of all ages. These include difficulties with production, marketing, funding, and repair of assistive devices. Lack of effective methods for getting devices from inventors to individuals who need them is a major obstacle to the use of these technologies (122).

The Impact of Multiple Impairments.—Many elderly individuals suffer from multiple chronic diseases with resulting functional impairments, and this affects the kinds of assistive devices and rehabilitation techniques they can use effectively (19). Rehabilitation technologies are often designed to compensate for impairment by substituting another function, yet this substitution of one ability for another is difficult when multiple impairments are present in the same individual. For example, an elderly individual who cannot walk because of an amputation, hip fracture, or osteoarthritis may not have the stamina to use crutches or a walker because of cardiovascular or respiratory disease. Similarly, an elderly blind person with paralysis of an arm due to stroke or decreased tactile sense due to diabetes will not be able to use braille to read.

Assessment of all the individual's functional impairments and residual strengths is a prerequisite for matching the individual and appropriate devices and services. Locating devices for an individual with a specific combination of impairments often requires a wide knowledge of available devices or a time-consuming search through catalogs. Although data are not available, it is likely that many assistive devices purchased for elderly individuals with multiple impairments are not used because the individual lacks the residual abilities needed to use the device.

Physiological changes that occur with normal aging can also restrict the use of rehabilitation technologies. These changes include decreases in visual acuity and hearing ability, decreases in touch sensitivity and fine motor control, decreased grip strength, and decreased capacity of the body to respond to environmental extremes (4). While these changes may not limit the functioning of the healthy elderly individual, they lessen capacity to compensate for impairments resulting from acute and chronic disease. For example, decreased grip strength may not interfere with the functioning of the healthy elderly person but can hamper the ability of a mobility-impaired individual to use a cane or grab-bars effectively. Awareness of the physiological effects of normal aging is essential for the design of rehabilitation technologies for the elderly.

The Impact of Confusion on the Use of Rehabilitation Technologies.—Although only a small percentage of all elderly persons have symptoms of confusion or organic brain disease, large percentages of the long-term care population are affected, including up to 50 percent of nursing home residents and 20 percent of community dwelling elderly over 80. The impact of confusion on their ability to use rehabilitation technologies has received little research attention, although anecdotal evidence indicates that it is an important factor.

A recent study of patients in rehabilitation facilities in Canada (99) showed that confused patients did not respond well to standard rehabilitation techniques. After a year 59 percent of not-confused patients had returned home, but only 16 percent of the severely confused patients had done so. The authors conclude:

> The standard rehabilitation approach depends on the patient learning ways to deal with the disability and practicing techniques taught by the therapist. Intellectual dysfunction impairs learning ability. Accordingly, it is not surprising that our data demonstrate this approach is not more effective than a standard supportive approach in which spontaneous improvement can occur.

The authors recommend the development of rehabilitation methods specifically for confused patients.

Confusion restricts the ability of the disabled elderly person to learn to use assistive devices such as walkers, hearing aids, or simple devices to help in dressing, bathing, or eating. Sometimes it is even difficult for the confused person to remember what the device is for. Failure to assess cognitive functioning may result in the purchase of assistive devices that are inappropriate for the patient.

Research findings about the effectiveness of rehabilitation technologies are also affected by the existence of mental confusion in the long-term care population. Formal research that does not distinguish between patients who are confused and those who are not may reach ambiguous conclusions, reflecting a mixture of positive results with one group of subjects and negative results with another group. Similarly, informal evaluations by long-term care providers who use rehabilitation technologies may produce neutral or negative results because many patients are too confused to learn to use the devices or respond to the rehabilitation techniques. As a result, providers often become discouraged about the efficacy of these technologies in general. Formal research that is clearly structured to differentiate between confused and not-confused subjects can help to identify technologies appropriate for these two groups of patients.

Negative Attitudes About the Rehabilitation Potential of the Elderly.—The belief that the elderly deteriorate inevitably, both physically and mentally, is widespread in our society, and affects the elderly, their families, health care professionals, and long-term care providers. The sense of hopelessness resulting from this belief is a significant barrier to the use of rehabilitation technologies.

As a result of these negative stereotypes, many elderly persons resist thinking of themselves as old and deny impairments that they think make them seem old. They may refuse to use assistive devices such as canes, walkers, and hearing aids that call attention to impairments even though use of these devices might help to maintain independent functioning. Other elderly persons, especially those who are recovering from a debilitating acute illness, accept the negative stereotypes about the inevitable deterioration and adopt a sense of hopelessness about recovery (19). In this state of mind, they are unlikely to respond well to rehabilitation services.

Family and friends of disabled elderly persons can be an important source of motivation and concrete assistance in obtaining assistive devices and helping the individual to install or learn to use them. Family members can help locate rehabilitation services, provide transportation, and encourage the disabled individual to cooperate with the rehabilitation plan, but family and friends who accept the stereotyped view that deterioration is inevitable are unlikely to offer encouragement and assistance in obtaining these services.

Health care professionals and rehabilitation specialists often share society's negative view of the elderly. Most physicians and nurses prefer younger patients and those whose ailments are curable (87), and some rehabilitation counselors also exhibit bias against the elderly (110). These negative attitudes result in lack of enthusiasm for the rehabilitation of the elderly and relative lack of rehabilitation research and services for this age group (61). Nevertheless, a recent study of rehabilitation in the very old patient (76) showed significant improvement in 79 percent of the 97 patients studied, all of whom were over 85. Interestingly, a computer search of U.S. literature failed to find any previous study of rehabilitation results with very old patients (76).

Photo credit: Gretchen Kolsrud

Many elderly patients can improve significantly with appropriate rehabilitation services.

The authors of a 1983 report emphasize the importance of well-designed research and clinical trials on rehabilitation of the elderly. They state:

> We want to avoid the self-fulfilling prophecy that shows elderly persons at poor risk for rehabilitation because statistics show less good results when, in fact, fewer therapies were offered in the first place (46).

They point out that evaluation of the rehabilitation potential of elderly patients is difficult when so few of them are ever offered rehabilitation at all.

Limited Availability of Skilled Rehabilitation Personnel in Long-Term Care Settings.—Most rehabilitation services and technologies for the elderly are provided in hospitals by physiatrists, physical therapists, occupational therapists, speech therapists, and nurses. As home care services have expanded, some of these rehabilitation specialists have begun working outside the hospital setting. As yet, however, too few are available to meet the needs of nursing home residents and community dwelling elderly. For example, occupational therapists are trained to evaluate functional impairment, locate or design appropriate assistive devices, and teach individuals to use them. Of the 35,000 members of the American Occupational Therapy Association, fewer than 3,000 work with elderly patients, and most of these work in hospitals.

Medicare funding for rehabilitation services outside the hospital is restricted by complex regulations about who provides the service and in which setting. Moreover, the patient must show improvement; services needed to maintain functioning are not reimbursable. Medicaid funding for rehabilitation services is available in some States, but coverage is limited, and the level of reimbursement is usually considerably below customary charges for these services.

Rehabilitation services for nonelderly adults are often provided and paid for by State rehabilitation agencies. These agencies receive 80 percent Federal funding as mandated by the Rehabilitation Act of 1973 and provide extensive services, including physical and mental rehabilitation, income maintenance during rehabilitation, transportation, counseling, mobility training for the blind, and telecommunication, sensory, and other assistive devices (122).

Although the Rehabilitation Act of 1973 includes no age criteria, it specifies that services be directed toward making the disabled person employable. This focus on employability has resulted in the virtual exclusion of the elderly from these services (71); figures from the Rehabilitation Services Administration for 1978 show that of the 290,213 persons who received rehabilitation services through federally funded State rehabilitation agencies, only 2.2 percent were over 65 (14).

The Rehabilitation, Comprehensive Services, and Developmental Disabilities Amendment of 1978 (Public Law 95-602) extended eligibility for federally funded rehabilitation services to severely disabled individuals who do not have employment potential. Mandated services include architectural modifications of homes and other living environments, attendant care, physical therapy, and assistive devices to help disabled individuals to function as independently as possible within their families or communities and to prevent or postpone institutionalization (139).

This focus on independent living services would seem to address the needs of the disabled elderly, except for two continuing problems. First, although some funds have been appropriated to set up rehabilitation programs for independent living, no funds have yet been appropriated to pay for the mandated services. Secondly, the elderly are in direct competition with younger disabled persons for services under these programs. Given the traditional focus of rehabilitation agencies on younger persons, the obvious need for rehabilitation services in the younger age group, and funding limitations, it is unlikely that the disabled elderly will receive substantial benefits from these programs without a significant redirection of financial and staff resources.

Problems in Production, Marketing, Funding, and Repair.—Ongoing difficulties in the production, marketing, funding and repair of assistive devices also restrict the use of these technologies by the disabled elderly. These problems include:

- *Inadequate Production and Marketing of Needed Products:* Many potentially useful devices are invented but never produced or marketed because companies are reluctant to invest in the manufacture of devices without an identifiable market for the product (7,55). In many cases the number of disabled people who can actually benefit from a certain device is relatively low, potential users are often difficult to identify (33), and small companies that are frequently the source of innovative products may lack the financial or staff resources to launch the kind of marketing campaign needed to reach potential users.
- *Lack of Information About Available Technologies:* Lack of information about assistive devices and rehabilitation techniques is an ongoing problem. Although computerized data systems and catalogs of devices have been developed to solve the problem, the information gap persists. Researchers complain that it results in frequent instances of "reinventing the wheel" (10,107). Disabled individuals, their families, and service providers continue to have difficulty finding out about appropriate technologies. Meanwhile, companies with innovative products and services struggle to find ways to make their products known to service providers and the disabled (34).
- *Lack of Financial Resources to Pay for Assistive Devices and Rehabilitation Services:* Three financial factors restrict purchases of rehabilitation technologies. First, disabled individuals as a group have lower than average income and are often unable to pay for these devices and services (55,122). Second, many devices are unexpectedly expensive because of the high costs of designing and marketing products to this relatively small group (33). Third, the many public and private agencies and programs that pay for rehabilitation technologies have uncoordinated and inconsistent definitions of who is eligible and what devices and services will be paid for.[18] Decisions about whether a device is covered under a certain program may vary from one part of the country to another, and can be made retroactively, so that neither the disabled individual nor the provider knows in advance whether the device or service will be paid for. In addition, the amount of payment for a specific device or service may be less than the full cost, and some devices are not covered at all (69). OTA has found that as a result of the lack of coordination among funding sources, "users and providers are either unable to take advantage of available technologies or must spend enormous amounts

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[18] Availability of funding for specific devices influences their production and use. Under some public programs, such as Medicare and Medicaid, such funding is authorized only when the devices are deemed "medically necessary." Hearing aids, glasses, dentures, and communications devices are not covered by Medicare because they are not considered medically necessary, although they do compensate for functional disabilities of disabled persons (122). In some cases, disabled persons find themselves with an inappropriate device because it is the only one that is funded (55,73).

of time providing the coordination needed to best assist each individual" (122).

- *Lack of Available Repair Services for Assistive Devices:* Difficulties in obtaining repair services for devices such as hearing aids and wheelchairs limit their usefulness. Repairs frequently take weeks or even months and are often costly. Replacement parts are hard to find, and for someone who is dependent on the device for an important functional disability, the time spent waiting for repair of the device can be very difficult (27).

INITIATIVES TO INCREASE THE AVAILABILITY OF REHABILITATION TECHNOLOGIES

Evaluative Research.—More research on the efficacy, safety, and cost of commonly used devices such as wheelchairs and hearing aids is needed, as are comparisons of outcomes when devices are used alone or in combination with rehabilitation training. Evaluation of rehabilitation technologies is one focus of the National Institute of Handicapped Research. The Veterans Administration, with its large population of disabled elderly veterans and its ongoing programs in both research and the provision of devices and services, also provides an ideal setting for evaluative research.

Assessment.—Accepted, valid, functional assessment measures are a prerequisite for evaluation of rehabilitation technologies and appropriate matching of individuals and technologies. Especially significant factors to measure are multiple functional impairments, mental impairments, and psychosocial factors that affect the capacity of the individual to use available technologies.

Public Education About Devices.—Initiatives to increase awareness of available rehabilitation technologies include advertising of specific products and public service advertising about the importance of rehabilitation technologies in maintaining independence and well-being. Advertising of specific products is clearly the responsibility of private industry, and some advertising of this kind, i.e., incontinence supplies, is currently underway in major national markets. Development of advertising for assistive devices has been difficult because the elderly tend to reject age-related product identifications (2). The design of advertising messages that emphasize both age and disability is even more difficult, and media advertising directors have been reluctant to accept advertising for assistive devices because of anticipated negative reactions to ad content. Although advertising for some types of assistive devices appears in magazines directed to the elderly and those with a health care focus, these publications do not reach all the individuals who might benefit from rehabilitation technologies or the families who often assist in obtaining them.

Public service advertising is an option that has not yet been tried. Advertising could emphasize the importance of assistive devices in maintaining independence and counter the widespread belief that using these devices implies that an individual is old, useless, and unattractive. Although the potential impact of this approach remains speculative, it is relevant to consider the positive effect on attitudes and demand for hearing aids when President Reagan first appeared in public with a hearing aid. Ads could refer to available sources of information about specific devices and encourage careful evaluation of both the needs of the individual and the appropriateness of the device chosen.

Awareness of Health Care and Service Providers.—Initiatives are needed to increase awareness of rehabilitation technologies among health care professionals and other service providers, such as physicians, nurses, social workers, physical therapists, occupational therapists, speech therapists, and staff members at senior centers, senior nutrition programs, and senior housing facilities. Although some of these individuals may have received training in some rehabilitation technologies, few have any knowledge of the wide range of technologies available. Retailers of assistive devices are generally untrained or trained through inservice programs provided by the manufacturers of the devices. They may develop expert knowledge about the devices they carry but rarely receive training in assessment techniques.

The development of training programs for health care professionals and service providers has been a major focus of the two Rehabilitation Research and Training Centers in Aging funded by NIHR. Curricula and audiovisual aids for training in rehabilitation of the elderly are being designed to increase knowledge about the elderly and to counter negative attitudes about rehabilitation potential, but the impact of these training programs has been limited by staff and funding restrictions at the centers, which were established only 3 years ago.

Rehabilitation counselors in State rehabilitation agencies generally have training in both assessment and rehabilitation technologies but lack funding and appropriate goals for working with the elderly. Increased funding for independent living services mandated by the Rehabilitation, Comprehensive Services, and Developmental Disabilities Amendment of 1978 is needed. Realistic goals for rehabilitation of the elderly are also needed. In addition to goals such as increased independence and self-care, it is important to recognize the roles the elderly can fill as volunteers in the community and caregivers in their own families (9).

Assistive Device Centers.—"Aids Centers," located throughout Sweden, enable disabled persons to look at assistive devices, try them out, and consult with rehabilitation specialists about which devices would be most helpful (35). In the United States, the Department of Justice maintains a Sensory Aids Center to evaluate and customize technological aids for its visually impaired and deaf staff members (112). In Sun City, a retirement community in Arizona, residents have organized a lending service for health care and rehabilitation appliances. Financial support is also available through the community for prostheses, glasses, and hearing aids (93) Development of assistive device centers in other locations would increase access to rehabilitation technologies by the elderly.

Funding.—Increased funding for rehabilitation technologies through Medicare and Medicaid is unlikely at present because of budget limitations, and without increased funding, coverage cannot be extended to new categories of assistive devices. Nevertheless, development of nationally consistent standards for Medicare and Medicaid coverage would facilitate provision of devices.

The need for increased public funding for assistive devices and rehabilitation services is not clear at present. The use of these technologies is limited primarily by lack of information, negative attitudes, and lack of a professional group with responsibility for assessment and matching of individuals and rehabilitation technologies for the elderly. Lack of funding discourages purchase of some expensive and technologically sophisticated devices, but many devices are relatively inexpensive, and recent reports tend to refute the idea that most of the elderly are poor (4). It is not clear how many elderly persons would be unable to pay for these devices if they knew about them and believed that the devices would help to maintain independence.

Technologies for caregivers

Technologies for caregivers include devices and procedures to facilitate and improve caregiving. Long-term care has traditionally been labor-intensive, with little emphasis on technology. Few labor-saving devices are used, and caregivers, including both informal caregivers and paid personnel, often receive little or no training in efficient methods of care. As a result, staff turnover is very high in long-term care facilities, and families and other informal caregivers become overburdened and exhausted.

Many technologies have the potential to facilitate long-term care. In this section, technologies to assist caregivers with three types of care are reviewed: 1) care for individuals with medical or skilled nursing care needs, 2) care for physically impaired individuals, and 3) care for mentally impaired individuals.

CARE FOR INDIVIDUALS WITH MEDICAL OR SKILLED NURSING CARE NEEDS

In the past few years, medical treatment that was previously provided only in hospitals has become increasingly available outside the hospital. This change has been spurred by the hospital utilization review process that discourages unnecessary hospitalization and by the availability of reimbursement for home health care through Medicare, Medicaid, and private insurance. The new Medicare prospective reimbursement system (DRGs) is increasing the need for medical services outside the hospital. Medical care devices and skilled nursing care are needed in the home and in nursing homes for patients who are discharged earlier from hospitals and continue to need medical treatment.

At present most nursing homes primarily provide personal care and supportive services under the supervision of a registered nurse.[19] Patients who are acutely ill or need complex medical treatment are sent to the hospital because most nursing homes do not have the resources to provide the required treatments. As hospitals respond to the prospective reimbursement system, nursing homes are being pressured to accept patients who need more acute care and more complex care than has been provided in the past.

Photo credit: Gretchen Kolsrud

Rehabilitation services can lessen the burden on caregivers by maintaining function even in the very frail elderly patient.

Technologies to provide more complex medical care in nursing homes include diagnostic and monitoring equipment and devices for sophisticated medical treatment. In addition, ancillary personnel with training in the use of these technologies will be needed. It has been suggested that geriatric nurse practitioners and nurse clinicians are well qualified to provide skilled and acute care services in nursing homes (67).[20]

The availability of medical technologies and qualified nursing personnel is primarily dependent on payment levels and reimbursement policies of Medicare, Medicaid, and private insurance companies. At present, payment for nursing home care is generally not high enough to cover the cost of sophisticated medical technologies and highly trained personnel. Cost-based reimbursement policies with increased allowance for medical devices and skilled personnel would create an incentive for nursing homes to upgrade the level of care they can provide, but would also increase the cost of nursing home care. Federal and State initiatives to limit reimbursement for nursing home care restrict the provision of acute and skilled care services that may be required by the patient group that is discharged earlier from hospitals under DRGs.

To a great extent, nursing homes can choose the patients they admit (see ch. 8). Without increased reimbursement for medical technologies and skilled nursing personnel, nursing homes are unlikely to admit patients with acute and skilled care needs because they do not have the resources to care for them. This creates severe hardship for patients who need ongoing medical care in an institutional setting and for hospitals forced to choose between discharging patients without adequate continuing care or keeping patients they are not being paid for.

Although the availability of medical care technologies and skilled nursing care in the home has increased greatly in the past few years,[21] demand for home health care will continue to rise as a result of the Medicare prospective reimbursement system. Primary concerns here are the continuing availability of highly trained nurses to provide skilled care and the existence of efficient mechanisms for testing and approving medical technologies for use in the home. Medical device regulation, which is the subject of several recent government reports[22] is not discussed here. The availability of skilled health care professionals to provide assistance and training for the patient and the family in the use of sophisticated medical devices is an important factor in the successful use of these technologies.

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[19] As of 1979 only 15 percent of nursing home staffs were registered nurses (RNs), compared with 46 percent of hospital staffs, resulting in a nurse-to-patient ratio of 1 to 49 in the nursing home compared with 1 to 4-5 in the hospital (68). RNs in nursing homes are responsible for supervision of nursing aides and many other administrative tasks in addition to medication-monitoring and medical treatments.

[20] The geriatric nurse practitioner is a nurse with a master's degree in gerontologic nursing and training in managing patient care, providing routine physical care and physical tests, and acting as liaison with the patient's physician. In addition, the geriatric nurse practitioner can provide staff training in the use of medical care technologies (42).

CARE FOR PHYSICALLY IMPAIRED INDIVIDUALS

Physically impaired elderly persons may require assistance with personal care activities such as bathing, dressing, eating, toileting, and mobility. Technologies to assist with these functions include devices that increase the ability of the elderly person to function independently (discussed in the previous section of this chapter), devices to assist the caregiver directly, such as machines to lift and move patients, and techniques to facilitate physical care.

Although many devices and techniques for caregivers are available, they are not widely used, and caregivers are often unaware of these technologies. Two factors interact to perpetuate this situation: First, caregiving is not generally recognized as a skill in our society. The focus is on curing rather than skilled caregiving (60). Second, and related to the first factor, is the relatively low status of most caregivers. It has been pointed out that:

Photo credit: Gretchen Kolsrud

This automatic chair lift is used to raise the patient comfortably into the whirlpool bath.

> Caring roles are for the most part performed by women with limited education, training, and professional identification and prestige. These are low paying jobs with virtually nonexistent status (60).

Even when these low-status caregivers develop effective caregiving techniques, there is little recognition of their skills or diffusion of the techniques to other caregivers.

Nurses, occupational therapists, and physical therapists are skilled in developing caregiving techniques for specific patients, but relatively few occupational therapists and physical therapists are employed in long-term care settings. Nurses provide training for nursing assistants in nursing homes and for home health aides and homemakers in home care agencies. Nevertheless, the lack of recognition for caregiving as a skill and the low status of caregivers limit the extent and effectiveness of this training.

Family members and other informal caregivers are particularly unlikely to know about and use available devices and techniques. In many cases, the informal caregiver is the elderly spouse, who has particular difficulty lifting and moving the patient in order to bathe or dress the patient or get him or her into a wheelchair. In fact, some nursing home placements occur when the caregiver has fallen or injured himself/herself trying to lift or move the patient. Packaging of information about devices and techniques for informal caregivers in a form that is easy to understand and use is an important priority in long-term care. Many devices for physical caregiving are designed for use in an institutional setting, and there is a need for devices developed specifically for home and the informal caregiver.

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[21] In contrast to the nursing home situation, payment *is* available for many medical care devices and skilled nursing visits in the home. In fact, Medicare reimbursement for one skilled nursing visit approaches the cost of a day of nursing home care in some parts of the country, although the nursing homes also provides 24-hour personal care, room and board, laundry service, and other supportive services.

[22] GAO, "Federal Regulation of Medical Devices—Problems Still to Be Overcome," September 1983; House Subcommittee on Oversight and Investigations, "Medical Device Regulation: The FDA's Neglected Study," April 1983; and Office of Technology Assessment, "Federal Policies and the Medical Devices Industry," OTA-H-230 (Washington, DC: U.S. Government Printing Office, October 1984).

CARE FOR THE MENTALLY IMPAIRED INDIVIDUAL

A large proportion of nursing home and board and care residents are mentally impaired, and many families are caring for severely confused elderly individuals at home, yet there has been relatively little attention paid to caregiving technologies appropriate for these individuals. The focus of Federal funding programs on physical illness and medical treatment has tended to obscure the care needs of mentally impaired individuals, but recent interest in Alzheimer disease has resulted in a growing literature on caregiving techniques for all mentally impaired patients. Some of this information is new, but much of it reflects existing knowledge of long-term care providers who have developed expertise in caring for these patients.

Effective care for mentally impaired individuals involves techniques for handling a variety of difficult problems. Table 17 lists the problems cited by families caring for mentally impaired individuals with Alzheimer disease, multi-infarct dementia, and other organic brain diseases (82). Technologies to address three of these problems, forgetfulness, agitation and catastrophic emotional reactions, and wandering, are discussed here.

Forgetfulness.—Increasing forgetfulness is characteristic of mentally impaired individuals and ranges from forgetting where one left certain objects to forgetting one's spouse and children and forgetting how to dress, eat, and use the bathroom. Memory training techniques have been tested with some evidence of short-term gain but little lasting improvement (143). Further research on a variety of approaches to maintaining memory function is needed.

For individuals with severe forgetfulness, caregivers can often help to maintain orientation with reminders about the date, the time, and other daily information. Several simple devices can also be useful. Labels on objects can remind the individual of the name of the object and illustrate its use with a simple drawing. Signs on doors, especially bathroom doors, can also be helpful. In one facility when a patient is so confused that he cannot answer any questions about himself, a color-

Table 17.—Behavior Problems of Patients Cited by Families

Behavior	Number of families responding	Number of families reporting occurrence (%)	Number of families reporting behavior to be a problem (%)
Memory disturbance	55	55 (100%)	51 (93%)
Catastrophic reactions	52	45 (87)	40 (89)
Demanding/critical behavior	52	37 (71)	27 (73)
Night waking	54	37 (69)	22 (59)
Hiding things	51	35 (69)	25 (71)
Communication difficulties	50	34 (68)	25 (74)
Suspiciousness	52	33 (63)	26 (79)
Making accusations	53	32 (60)	26 (82)
Meals	55	33 (60)	18 (55)
Daytime wandering	51	30 (59)	21 (70)
Bathing	51	27 (53)	20 (74)
Hallucinations	49	24 (49)	16 (42)
Delusions	49	23 (47)	19 (83)
Physical violence	51	24 (47)	22 (94)
Incontinence	53	21 (40)	18 (86)

SOURCE: P. V. Rabins, et al., *Journal of the American Medical Association*, 248(3):333-335, July 16, 1982. Copyright 1982, American Medical Association.

ful poster is placed outside his room, giving his name and some information about his family and his past and providing staff and visitors something real to talk to the patient about (136).

Little information is available about effective techniques for maintaining the individual's memory of how to care for himself (bathing, eating, toileting, etc.). This is partly because in many long-term care settings, no distinction is made between patients who need help with these functions because of mental impairment and those who need help because of physical impairment, and staff members tend to provide the same kind of assistance for both groups. Informal caregivers often provide physical assistance instead of using techniques that support the individual's ability to perform self-care functions himself. Research on effective techniques for maintaining memory of self-care functions is needed.

Agitation and Catastrophic Emotional Reactions.—Agitation and catastrophic emotional reactions are major problems for caregivers. These behaviors are related to memory loss because the individual becomes agitated and angry when he cannot remember or understand people and events in his environment. Although there are no devices to cope with this problem, medication can be used. Unfortunately some medications that are frequently used for this purpose also reduce alertness and other cognitive functions.

Certain caregiving techniques and systems can decrease the frequency and severity of agitation and catastrophic reactions. Informal and paid caregivers can learn to divert the individual's attention from upsetting issues or events and to avoid presenting the individual with tasks he is not able to perform (82). In addition, caregivers can be aware of the impact of daily events on the mentally impaired individual. For example, in the institutional setting, mentally impaired individuals may become agitated when shift changes or visitors to the facility cause high levels of activity and noise. An understanding of the effect of these events on the confused person can result in environmental and scheduling changes that decrease the frequency of catastrophic emotional reactions.

Wandering.—Wandering is a difficult problem for families and long-term care facilities because mentally impaired patients, particularly those with Alzheimer disease, are often physically healthy and able to wander away quickly, becoming lost and endangering their safety. As a result, they require constant supervision.

Some mentally impaired wanderers believe they are going to a specific place or accomplishing a specific job, while others seem to wander aimlessly, drawn from one stimulus to another (105). This behavior often increases when the individual becomes agitated, and one study has suggested that wanderers may be individuals who had a lifelong pattern of responding to stress with activity, such as walking or pacing (70).

Methods for preventing wandering have included the use of drugs, which often have side effects that worsen the individual's physical and mental condition, "protective devices" that involve tying the patient to a chair, and locked doors that prevent the individual from leaving a certain area. In a long-term care institution, the availability of a locked nursing unit allows the wanderer to move around freely within the unit; the locked unit is, however, very restrictive for other residents who are not confused (28). For the informal caregiver, living in a totally locked space with a mentally impaired individual can be extremely stressful.

Technologies for wanderers include devices, programs, and environmental design to allow some freedom of movement while maintaining the caregiver's sense of certainty about where the individual is. Some long-term care facilities have installed electronic monitoring systems that activate an alarm at the nurses station when a patient wearing the signaling device goes through a monitored doorway. These devices cost up to $1,000 per monitored door. Other facilities have installed special door knobs and locks that can easily be opened by mentally normal patients, staff, and visitors, but not by mentally impaired patients. Programs for wanderers include frequent structured and unstructured opportunities for physical exercise, such as exercise groups and walks with staff or visitors. Environmental design technologies include living areas and outdoor spaces structured with pathways that allow the individual to wander within an overall enclosed space.

SUPPORT GROUPS FOR CAREGIVERS

Support groups for informal caregivers have been formed in many communities. Most of these groups are designed primarily to provide emotional support by encouraging caregivers to discuss the complicated feelings and difficult decisions involved in caring for impaired elderly individuals. In addition, support groups allow for sharing information about mental and physical impairments, available resources, and techniques of caregiving (37). Although there has been very little emphasis on technologies for informal caregivers, these groups could provide an opportunity for exchanging information about available devices. By providing emotional support and information for informal caregivers, support groups can help to decrease stress and may increase the willingness and capability of families to maintain impaired individuals at home.

PROGRAMS FOR PHYSICALLY AND MENTALLY IMPAIRED INDIVIDUALS

Effective systems of caregiving include not only devices and procedures for physical care but also a program of social and recreational activities. While these activities provide diversion and entertainment, they can also increase the patient's involvement with others and with his environment. Activities designed to foster a sense of usefulness, involvement, and responsibility can help to overcome feelings of helplessness that are common among long-term care patients. Examples of these activities include:

- resident councils and other self-government activities;
- formal and informal opportunities for individuals to assist other patients, such as the Retired Senior Volunteer Program (RSVP) that has been set up in some nursing homes to recognize and support volunteer efforts of patients for other patients;
- group projects to benefit the nursing home or a community agency, such as the "Rock and Roll Jamborees" held in some nursing homes to benefit the Heart Association;
- opportunities to care for plants or gardens; and
- pet visitation programs.

Photo credit: Gretchen Kolsrud

In Montgomery County, MD, 4-H clubs have trained parakeets to be given as pets to nursing home residents.

By supporting the patient's sense of active involvement and competence, these activities can increase self-esteem and counter feelings of helplessness and dependency that undermine motivation for independent functioning and self-care.

Long-term care delivery systems

Methods of providing long-term care services for the elderly include organizations and funding mechanisms for developing and coordinating resources and matching the needs of the individual with appropriate services and facilities, such as nursing homes, board and care facilities, home care, adult day care, hospice, and congregate housing. Some or all of these services are available in most communities, but the complexity and fragmentation of long-term care services at the community level make it difficult to connect elderly individuals with the services they need.

Decisions about long-term care are often extremely traumatic for the elderly and their families. These decisions are frequently put off until a crisis point is reached because of the intense emotional issues that are involved. The elderly fear loss of independence and the possibility that they will have to move from a familiar home environment. Families may experience a combination of sadness about the elderly individual and guilt that they are unable or unwilling to provide the care that is needed. Within this complex emotional environment the fragmentation of the service delivery system at the community level compounds the trauma to the elderly individual and the family.

This section discusses the existing service delivery system, and alternative methods for linking the individual with appropriate long-term care services.

THE PATCHWORK OF SERVICES

In most communities long-term care services are provided by a variety of public and private agencies with differing eligibility requirements, services, and funding mechanisms, resulting in what one author has called a "patchwork array of services" (24). The services are generally not coordinated. Overlapping services and gaps in available services are common, and there is often no single source of information about what services are available. As a result, it is difficult for patients, their families, physicians, and other health care and social service providers to locate appropriate services. When impaired elderly individuals need several long-term care services from different agencies, coordination can be very difficult (3,132).

The fragmentation of agencies and services at the community level is partly a result of the way these services have developed over time. New agencies have been created in response to specific needs, and there is often no comprehensive plan for how the new services will mesh with existing services in the community.

Another and perhaps more important cause for the fragmentation is the complexity and lack of coordination of regulations controlling government programs that fund these services. As stated earlier, government funding programs have a substantial impact on the kinds of services that are available at the community level. Although some private agencies do not accept any government funding, most agencies and long-term care facilities provide at least some government-funded services, and as a result, their services and eligibility requirements usually reflect government regulations. Government regulations about services that are "reimbursable" often define which services are available in the community because agencies tend to develop and provide those services that will be paid for. Similarly, regulations about the qualifications of agencies that are certified for reimbursement through government programs often define the kind of agencies that will be developed.

Unfortunately, the government programs that have such a major impact on long-term care services are themselves uncoordinated. A 1977 GAO report described four Federal programs that provided funding for home care services at that time: Medicare, Medicaid, Title XX of the Social Security Act, and Title III of the Older Americans Act. The report concluded that "the various Federal home health programs defy coordination" (115). Since that time, new regulations have tended to increase the complexity of these programs.[23]

Other Federal, State, and local programs that affect the availability of long-term care services include Social Security, Supplemental Security Income (SSI), benefits available through the Veterans Administration, and programs developed and funded by State and local health departments and social service departments. Each of these government programs has differing eligibility requirements, benefits, and funding mechanisms, increasing the complexity of the long-term care system at the community level and limiting access to appropriate services by the elderly.

METHODS FOR IMPROVING COORDINATION AND ACCESS TO LONG-TERM CARE SERVICES

The fragmentation of the long-term care system has been noted for more than 20 years (21,100), and several methods have been developed to improve coordination and access to services. These include: 1) efforts to coordinate agencies and services at the community level, 2) case management approaches designed to locate and coordinate services for the individual, and 3) efforts to provide a full range of long-term care services within a single agency or program. These methods are reviewed briefly here, and government initiatives to increase the role of individuals in planning their own long-term care are discussed.

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[23] State and local regulations also affect eligibility, benefits, and funding for three of these programs; Medicaid, Title III of the Older Americans Act, and the Title XX Block Grant.

Each of these methods can be seen as an attempt to rationalize the system at the community level. While each is effective in some ways, they cannot change the underlying problem, which is the lack of coordination in the major Federal programs that regulate and finance long-term care.

Coordination of Agencies and Services at the Community Level.—Methods to improve coordination at this level can include:

- formal mechanisms for exchanging information between agencies, such as the regular meetings of long-term care providers now held in some communities;
- development of a directory of all long-term care services available in the community;
- development of a centralized information and referral service;
- mutual referrals and cooperation in handling individual clients (case conferencing); and
- joint planning and policymaking to avoid duplication and gaps in available services.

In the past, efforts to coordinate services have been organized by public agencies, such as the health department or the department of social services, or by a private agency or voluntary association founded for this purpose. This remains the pattern in some communities; in others, the Area Agency on Aging (AAA) has become the lead agency for coordination of services. One of the mandated functions of the AAAs, which were established by the Older Americans Act, is coordination of community services for the elderly (3); in some communities AAAs have provided funding and organizational support for each of the approaches listed above.

Efforts to coordinate services have been only moderately successful in most communities; inflexible Federal and State regulations, that often cause much of the complexity in the system, have been a limiting factor. Moreover, community agencies may resist coordination because of a commitment to existing agency structure and policies. One author has pointed out that successful coordination of agencies and services is a time-consuming and expensive process requiring a leader who is "a super-being with optimum political skills, administrative competence, missionary fervor, and familiarity with the entire range of professional interventions and management techniques" (21).

Case Management Programs.—A second method for coping with the fragmentation of the long-term care system and improving access to appropriate services is case management, a system for "developing and coordinating client care plans and monitoring the treatment process" (125). In the context of the complex array of long-term care services, it is the function of the case manager to assess the needs of the client, develop a plan of care, and arrange services to implement the plan. Many State and local communities have established case management programs, and a 1980 study by Andrus Gerontology Center identified more than 300 such programs. Most of these programs, however, did not coordinate a comprehensive range of services; some coordinated only social services, while others coordinated mainly health care services (125).

Case management was a major component of several long-term care demonstration projects funded by the Federal Government in the 1970s.[24] These projects were designed to test whether home and community based long-term care services could substitute for nursing home care, and the case manager was responsible for assessing the client's needs and referring the client to appropriate services. All of the projects also provided new home care services or new funding for services that were already available. Evaluation of the effectiveness of the case management approach in these projects is difficult because changes in client outcome could have resulted from the case management, the new long-term care services, or both. None of the projects included a research design to test the efficacy of case management in reducing fragmentation of long-term care services for the clients (125).

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[24] Examples of these demonstration projects are ACCESS, in Monroe County, NY; the Alternative Health Services Project in Georgia; the Community Based Care Systems for the Functionally Disabled in Washington State; the Wisconsin Community Care Organization; and Triage, in Connecticut.

In 1980, the Department of Health and Human Services and the Administration on Aging jointly funded the National Long-Term Care Channeling Demonstration Program specifically to evaluate the effectiveness of case management in reducing fragmentation of services. Ten States are participating in the program to test two models of case management. Five States are using the "basic" channeling model that includes assessment of client needs, care planning, and arrangement of appropriate long-term care services. The "complex" channeling model being tested in five other States includes the basic case management functions plus several additional features: the case manager has authority over the amount and duration of noninstitutional health and social services the client receives, and the cost of services for all clients is capped at a level equal to 60 percent of the cost of nursing home care in the demonstration area. The Channeling Demonstration Program will run from 1982 to 1985, and results are expected to provide definitive answers about the effectiveness of case management in facilitating client access to appropriate long-term care services (79).

The Facilitator and the Gatekeeper.—The functions of the case manager in long-term care demonstration projects (including the channeling program) illustrate two different approaches to service delivery. In some demonstration programs and the "basic" channeling model, the case manager functions primarily as a facilitator, assisting clients to obtain appropriate services. In other demonstration programs and the "complex" channeling model, the case manager also functions as a gatekeeper, controlling and limiting access to services, especially high-cost services such as institutional care. Although there has been little discussion in the literature of the relationship between these two roles, they seem to involve inherent internal inconsistencies for the case manager who must decide whether to arrange for all the services the client needs or to focus on limiting costs. For the individual client who needs certain long-term care services, the facilitator approach could be expected to result in provision of those services. It is not clear whether the same services would be provided when the gatekeeper approach is used. Comparison of the results of the two models of channeling may help to resolve this question.

The distinction between these two approaches reflects the two primary concerns of government in long-term care: concern with cost control and concern with providing access to appropriate services for the elderly. In the absence of a comprehensive national long-term care policy, the relative emphasis on these concerns can be expected to vary from one government program to another and from one community to another in a manner that is in many instances both confusing and inequitable.

Targeting.—Targeting of long-term care services to the most impaired individuals combines the facilitator functions of assessment and identification of needs and the gatekeeper functions of controlling and limiting access to services. Many analysts of the long-term care system have emphasized the importance of targeting services in order to control costs while providing essential services (80,118). While the concept of targeting represents a merging of the facilitator and gatekeeper functions, its implications require further definition. Decisions about the kind and amount of services that will be provided with government funding are a matter of public policy, and the concept of targeting does not in itself answer the difficult questions about resource allocation or resolve the ambivalence of government about its central concern in long-term care.

Use of Computerized Information Systems.—The complexity of agencies, services, funding mechanisms, and client needs at the community level suggests a possible application for computer-based information systems in long-term care. Computers are now being used in health and social service agencies for applications such as recordkeeping and program analysis, and some service providers have begun to use computerized information systems to aid in matching individual needs and available long-term care services (72). OTA has not assessed the efficacy of this approach, but it appears to provide an improved information base for long-term care decisionmaking. Concerns about the impact of this approach on client autonomy and confidentiality of client information should be resolved prior to implementation of these systems.

Provision of a Comprehensive Range of Long-Term Care Services Through a Single Agency or Program.—A third method for increasing the coordination of long-term care services and facilitating client access to services is provision of a comprehensive range of long-term care services by a single agency or program. The Veterans Administration is the largest and best known example of this approach. Other examples are social/health maintenance organizations and agencies offering life care contracts. Recently hospitals have become more involved in the provision of long-term care services. Each of these agency types is discussed briefly with emphasis on its effectiveness in overcoming the fragmentation of long-term care services.

The Veterans Administration (VA).—The VA provides an extensive system of long-term care services including nursing home care, board and care, and home care. Adult day care, hospice, and respite care are also available in some areas (80). Institutional services are provided in VA Medical Centers and domiciliary care facilities, while home care services provided by the VA are most often available in areas near the VA Medical Centers (79).[25] Eligibility for VA services depends on a complex system of entitlements focused first on the presence of service-connected disability and secondly on measures of need and ability to pay (97). Although there has been little emphasis on targeting mechanisms, increased targeting of services is an option being considered in response to the increasing number of veterans eligible for VA services. The VA employs a large number of social workers who are responsible for patient assessment and coordination of services within the VA system and for contracted services in the community (80).

Although analysis of VA long-term care services is beyond the scope of this report, two points are relevant to the functioning of the VA as a delivery system. First, the cost of VA long-term care services such as nursing home and home care programs is higher than similar services provided by other government or private agencies (97). It is unclear whether these higher costs are related to the level of care needed by VA patients, the quality of care provided by the VA, or possible inefficiencies in the VA system of delivering services. Second, many elderly individuals who are eligible for long-term care through the VA choose instead to use non-VA services, relying on Medicare, private insurance, and personal funds to pay for these services (97). The reasons for this choice are not known, but some possibilities are: 1) lack of VA facilities near the individual's home and reluctance of the individual to leave his community; 2) the belief of some individuals that VA services are inferior to similar services provided by the private sector; and 3) a perception of the VA as a large, impersonal bureaucracy in which the preferences of the individual might be disregarded. Further analysis of these issues is needed to clarify the advantages and disadvantages of service delivery in the VA model.

Social/Health Maintenance Organizations (S/HMOs).—S/HMOs are agencies that provide a comprehensive range of long-term care services using management and reimbursement principles developed by HMOs (health maintenance organizations) to deal with the fragmentation of services in the community and avoid unnecessary hospitalization and nursing home care. Cost control is a major focus of the S/HMO. Clients pay a predetermined monthly rate and are thereby eligible for services they need including acute medical care, nursing home care, adult day care, home health care, housekeeping, and chore services.

On Lok is a San Francisco agency that has been using HMO principles to provide a comprehensive range of long-term care services in the Chinatown-North Beach area since 1979 (101). On Lok's own research indicates that their clients used less hospital care and less nursing home care than a comparison group and that measures of physical health and functional status indicated more improvement in the On Lok group than the comparison group (74). The On Lok cost per client per day in 1981 was $37.68, which includes all medical and social services but not the cost of housing, food, or other living expenses. Although accurate comparison is difficult, the Medicaid rate for skilled nursing home care in California at that time was $36.88 per day, which does not include costs of hospitalization, physician's services, or physical therapy. If the cost of these services is included, On Lok estimates that the true cost of care for patients in skilled nursing facilities would be comparable to On Lok's cost plus the housing and living expenses of On Lok clients (101).

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[25] The VA also contracts with private nursing homes and community home care agencies to provide services when VA facilities are full or when there are no VA facilities in a given geographical area. These contracted services are not relevant to this discussion of services actually provided by a single agency, but it is interesting to note that when the VA contracts with community agencies for services it cannot provide, it experiences many of the same problems in coordination of services that have been described in the beginning of this section. At present, there is ongoing discussion and debate within the VA about how the VA can best coordinate its services with non-VA services in the community.

While there is some question about the validity of the results of the On Lok research because of the comparison group used, there is considerable interest in the S/HMO approach. At present, several S/HMO sites are being developed by Brandeis University as part of a 3-year demonstration project funded by the Health Care Financing Administration. Evaluation of the results of this project is expected to provide information about the efficacy of the S/HMO approach for delivering services and improving client access to appropriate care (118).

Some researchers believe that the S/HMOs will reduce the cost of long-term care by substituting home health and nonmedical home care services for hospital and nursing home care (30). The Federal Office of Management and Budget (OMB) disagrees and expects that S/HMOs will raise the cost of long-term care and create a precedent for providing nonmedical services that are not currently covered by Medicare and Medicaid (89).

Life Care Communities.—Life care communities are long-term care systems that provide a continuum of services for elderly residents, including homes or apartments for independent living, home care services, and infirmary or—in many instances—nursing home care. Hospital care is usually not provided, but individuals are guaranteed that they can return to the life care community following hospitalization.

There are about 275 life care communities in this country, providing housing and care for about 90,000 elderly people (6). Most life care communities are privately owned, and many are run by religious organizations. Elderly individuals are usually admitted while they are still able to function independently. Payment of the initial membership fee and a monthly fee guarantees the individual long-term care for the rest of his life. Because the membership fee and monthly fees are often very high, this type of long-term care has been used primarily by relatively wealthy individuals, but religiously based and nonprofit life care communities do admit some low and moderate income individuals. Sometimes Medicare or Medicaid reimbursement is available for home care or nursing home services provided in these communities.

Life care communities allow the elderly individual to select a system of long-term care before he needs any services, thus increasing his sense of control over his future. In addition, the availability of a range of services within the same community eliminates the need to move to a completely new environment when services are needed, thereby avoiding the trauma that is often associated with moves.

Despite these positive indications, reported financial and management problems of some life care communities have dampened enthusiasm for this long-term care option (59). Poor financial planning, often related to lack of accurate statistics about life expectancy for residents, has led to several bankruptcies (92), and a recent report has pointed out the need for improved actuarial planning (141). About one-third of States have laws governing life care communities, and other States are considering legislation (78). Legislation to protect the financial investment of residents and at the same time encourage the development of life care communities could make this option available to more elderly individuals.

Many of the Nation's largest nursing home chains have begun to diversify into housing and home care services for the elderly. In testimony before the Senate Subcommittee on Aging, July 14, 1983, Arnold Richman, chairman of Meridian Health Care, described his company's recent involvement in the provision of home care services including skilled nursing care, homemaker and chore services, and respite care. The company has developed housing for the elderly and is considering development of a retirement community with rental apartments for the elderly and a nursing center that would provide board and care services and skilled nursing care. Mr. Richman stated:

> While it is difficult for a proprietary provider of services to be a direct provider of life care services, we believe there is a significant untapped need for the rental concept which does not have associated with it the large entry or endowment fees typically associated with life care (90).

Evaluation of the potential role of profit-making organizations in the development of life care communities to serve low and moderate income elderly is needed. Such an evaluation should focus on the cost of care and the effectiveness of this approach in reducing the fragmentation of long-term care services.

Hospital-Based Service Delivery Systems.—With the advent of government-initiated cost control programs, particularly the Medicare cost-based reimbursement system (DRGs), hospitals have become more involved in developing and coordinating long-term care services. The cost control systems limit reimbursement to the hospital when the patient no longer needs acute care, but most hospitals are reluctant to discharge patients without appropriate plans for continuing care. In order to provide discharge options for their patients, some hospitals are developing or acquiring nursing homes, home care agencies, adult day care centers, and community outreach services, while others are establishing formal transfer agreements between the hospital and these long-term care agencies.

Advantages of hospital-based service delivery systems are: 1) the prominence of hospitals in the community which makes them a well-known center for service delivery, and 2) the availability of physicians in the hospital to provide and supervise long-term care. Lack of physician involvement in nursing homes and home care agencies has been a major concern for many years, and affiliation of long-term care agencies with hospitals offers the possibility of alleviating this problem (22). Provision of long-term care services within the hospital system could also allow easier transitions for patients between acute and long-term care settings.

In many communities, empty hospital beds are driving up the cost of hospital care. Affiliation with long-term care agencies provides a guaranteed source of patients for some of these hospitals. Other hospitals are using empty beds to provide long-term care in the hospital. This approach could lessen the need to build new nursing homes and decrease costs associated with empty hospital beds. In some rural areas, Medicare reimbursement is now allowed for these "swing beds" that can be used for acute or long-term care services depending on current need (22).[26]

One disadvantage of hospital-based service delivery systems is that the hospital is a medical care facility, and hospital coordination of service delivery can result in overemphasis on medical care and lack of social or nonmedical services. The fact that reimbursement is more often available for medical care than for social services is an additional incentive for hospitals to provide primarily medical services. This tendency to medicalize the long-term care system is a problem because of the relatively high cost of medical care compared to social or nonmedical services and because in some instances nonmedical services are more appropriate for the patient. Further analysis of the impact of hospital-based service delivery systems on the kinds of services provided and the cost of care will be needed as this method of coordinating long-term care services is more widely used.

Government Initiatives To Increase the Role of Individuals in Developing Their Own Long-Term Care Plans.—This option has thus far received very little attention for several reasons. First, long-term care is frequently seen as medical care, and planning is seen to require medical expertise. Second, individuals who need long-term care services are often treated as if they were so mentally and physically disabled that they cannot make long-term care plans for themselves. Third, there is a sense of crisis that surrounds long-term care decisionmaking and interferes with the deliberate consideration of individual preferences and alternatives for care. Finally, the complexity and fragmentation of long-term care services make it difficult for individuals to understand what alternatives are available.

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[26] Medicare and Medicaid regulations and some State and local regulations prohibit hospital provision of long-term care services and acquisition of long-term care facilities to avoid restraint on competition between local agencies.

In fact, information reviewed in this chapter indicates that functional impairments rather than medical conditions are most apt to cause a need for long-term care services and that increasing proportions of individuals in each older age group need assistance with personal care and housekeeping services. To the extent that functional impairments and the resulting need for long-term care services can be anticipated by the elderly, it is possible that some individuals could plan for these services.

Government initiatives to encourage and assist individuals to plan for their own long-term care could focus on public information programs to increase awareness of:

- functional impairments and their impact on the need for long-term care services,
- the potential for rehabilitation of the elderly and the role of assistive devices in maintaining and increasing independent functioning,
- the kinds of long-term care services that are available, and
- the importance of housing and living arrangements in postponing the need for more formal long-term care services.

Clearly the development of a more rational and coordinated system of long-term care services would also help individuals to plan long-term care for themselves.

One of the greatest fears of the elderly is becoming frail and dependent on others. Government initiatives to encourage elderly individuals to plan for themselves may help to alleviate this fear and assure them continuing control of their lives.

Findings

The need for long-term care is expected to increase dramatically in the future as a result of several factors:

- growth in the number of elderly individuals, particularly the very old who frequently need long-term care services,
- decreasing age-specific mortality that results in larger numbers of elderly individuals living longer with chronic diseases and functional impairments, and
- changes in medical practice and reimbursement mechanisms that result in limiting inpatient care and the length of hospital stays and promoting delivery of health care services in the home and the community.

Increasing need for long-term care will place strain on families, existing agencies, and service delivery systems. Public and private expenditures for formal long-term care services which have grown rapidly in the past 20 years, will continue to rise.

Technology has not been widely used in long-term care. Identification of technologies that are appropriate for this population requires a needs assessment, but this assessment is complicated because government programs that regulate and fund more than half of long-term care services in this country tend to define the kind of needs that are recognized, emphasizing medical and skilled nursing care and obscuring the need for other forms of care. Survey data collected from agencies serving Medicare and Medicaid patients reflect this influence.

In contrast to this emphasis on medical and skilled nursing care, research indicates that long-term care services are most often needed as a result of functional impairment; that is, limitations in the individual's ability to function independently. Medical treatment can cure some of the conditions that cause functional impairment, but other conditions are not curable at present. Biomedical research has been focused primarily on conditions that cause death, but conditions that cause functional impairment are not necessarily the same as those that cause death. Research on conditions that cause functional impairment could result in effective treatments and decreased need for long-term care.

In the absence of effective medical treatments, alternative approaches to maintaining independent functioning are needed, such as assessment technologies to identify functional impairment and assistive devices and rehabilitation techniques to compensate for functional impairment. Use of these technologies has been limited because of the focus on medical and skilled nursing care, and because physicians and other long-term care providers lack training in their use. Reimbursement for the use of assessment technologies is limited, and there is disagreement about the reliability and validity of existing assessment measures. Factors restricting the use of assistive devices include lack of information about available devices, the difficulty of selecting appropriate devices for individuals with multiple impairments, and negative attitudes of elderly individuals, their families, and many health care professionals about the rehabilitation potential of the elderly.

Some elderly individuals have mental conditions that cause functional impairment and a need for long-term care. While it is known that about half of residents of nursing homes and board and care facilities have mental conditions that cause confusion, it is not known how many of these individuals are functionally impaired as a result of confusion, how many are functionally impaired as a result of other chronic conditions, and how many have both physical and mental conditions causing impairment. The development of devices and care techniques for confused patients has received little attention although families and formal long-term care providers often have great difficulty caring for these individuals.

Because of the emphasis on medical and nursing care in the Federal programs that regulate and fund long-term care services, alternative care systems such as board and care facilities and personal care and supportive services in the home are often not available. Physically and mentally impaired patients who need 24-hour supervision and personal care services but not skilled nursing care are often admitted to nursing homes although they might be cared for in less restrictive and less costly board and care facilities. Similarly, individuals who need personal care and supportive services at home may not receive the care they need or may receive health care services they do not need because of Medicare and Medicaid funding regulations. Negative attitudes about the concept of custodial care and fears about the cost of providing nonmedical long-term care services for the functionally impaired elderly also limit the availability of these services.

Most long-term care services are labor-intensive, and formal and informal providers receive little training in the use of devices and techniques to facilitate caregiving. Increased development and use of these technologies could lessen the burden of caregiving, allowing some families to keep elderly relatives at home longer and decreasing staff turnover in long-term care facilities.

Few medical care technologies have been used in long-term care facilities or in the home. Recently, as a result of the implementation of the Medicare prospective reimbursement system and increased emphasis on the provision of health care services at home, medical care technologies that have been available only in hospitals are being used more often in the home. This trend is expected to grow, and demand for sophisticated medical and nursing care technologies in nursing homes is also expected to grow. The increased use of these technologies outside the hospital is dependent on the availability of funding and skilled health care personnel trained to use these technologies and to teach the patient and the family to use them.

Long-term care services are provided by nursing homes, board and care facilities, and home care agencies. In some communities, adult day care facilities, hospice programs, and congregate housing facilities also provide services. Little information is available about differences between agencies in the services they provide and the kinds of individuals they serve, and it often appears that most agencies provide a wide range of services to a variety of patients with very different needs. Increasing the use of technology in these agencies would be difficult and expensive because so many different technologies would be required to meet the varied needs of patients served by each agency.

An alternative is to classify patients according to need and to provide a unique set of technologies and care systems in each agency. The feasibility of this alternative depends on whether patients can be realistically grouped according to need and whether available assessment technologies can accurately classify patients in this way. When patient needs change frequently, the negative effect of moving can outweigh the positive effect of appropriate technologies in the new setting. These issues require further evaluation.

Lack of coordination among the Federal programs that regulate and fund long-term care services contributes to the fragmentation of services at the community level, making it difficult for the elderly, their families, and health care professionals to arrange appropriate services and increasing the sense of crisis that surrounds long-term care decisionmaking. Efforts to improve service delivery have included techniques for coordinating agency services at the community level, case management systems, and organizational approaches that provide a range of services through a single local agency. Development of a more coordinated system of services could enhance the ability of some elderly individuals to plan effectively for their own long-term care.

Research priorities

Research priorities related to the development, utilization, and evaluation of technologies to meet the needs of the long-term care population include:

- identification of the primary causes of functional impairment and biomedical research to find cures or treatments that alleviate the functional impairment;
- development of assistive devices and rehabilitation techniques for elderly individuals, particularly those with multiple impairments;
- evaluation of the relationship between mental confusion and functional impairment and the impact of mental confusion on the need for long-term care;
- identification of assistive devices and rehabilitation techniques that are effective with confused individuals;
- assessment of devices and techniques to facilitate caregiving;
- evaluation of the reliability and validity of available assessment measures in classifying patients according to service and technology needs; and
- comparison of the cost and quality of care effects of providing a variety of technologies in each long-term care agency v. moving patients to settings that provide a unique set of services and technologies to meet specific needs.

Issues and options

Use of assessment measures

Issue 1: Should Congress encourage the use of comprehensive assessment technologies?

Options:

1.1: Congress could maintain current levels of support for the use of comprehensive assessment measures in demonstration projects.

1.2: Congress could increase funding for evaluation and consensus development on effective assessment measures.

1.3: Congress could increase funding for training health care professionals and other long-term care providers in the use of comprehensive assessment technologies.

1.4: Congress could mandate reimbursement through Medicare and Medicaid for physicians and other long-term care providers for comprehensive assessment.

1.5: Congress could mandate reimbursement for comprehensive assessment provided in Geriatric Assessment Centers.

1.6: Congress could make eligibility for publicly funded long-term care services dependent on the results of a comprehensive functional assessment measure.

Comprehensive evaluation of the physical, mental, and social functioning of the impaired elderly individual is important for identifying medical care needs, functional impairments, and appropriate technologies and long-term services. Federal initiatives to provide training and reimbursement for health care professionals and other long-term care providers in the use of available assessment measures can be expected to increase utilization. Mandated use of comprehensive assessment measures to determine eligibility for federally funded long-term care services would have a much greater effect, ultimately leading to increased awareness of the multiple factors involved in the need for long-term care and the variety of technologies and services that are appropriate for this population.

Functional impairment

Issue 2: Should Congress mandate funding for long-term care services based on functional impairment?

Options:

2.1: Congress could maintain current emphasis on eligibility for services based on need for medical and skilled nursing care.

2.2: Congress could expand existing programs to include eligibility for long-term care services on the basis of functional impairment.

2.3: Congress could create a new program to fund long-term care services for functionally impaired individuals who do not need continuous medical or skilled nursing care.

Research has demonstrated the importance of functional impairments in causing the need for long-term care services, but, as a result of the emphasis in Federal funding programs on medical and skilled nursing care, some elderly individuals with functional impairments are not eligible for the services they need. Providing reimbursement for services based on functional impairment would increase the number of eligible individuals and probably increase overall costs. The availability of funding for nonmedical services could, however, encourage the development of alternative care systems such as board and care facilities and personal care and supportive services in the home that are significantly less costly than medical and skilled nursing care. These alternative care systems could emphasize the use of technologies for caregivers and environmental design technologies that limit the impact of functional impairments. Since it is not known how many nursing home residents and home care clients need skilled nursing care and how many need only personal care, supportive services, and supervision, no reliable estimate can be made of the number of individuals who could be cared for with lower cost, alternative services.

Rehabilitation technologies

Issue 3: Should Congress implement policies to increase the use of assistive devices?

Options:

3.1: Congress could maintain current levels of support for the use of assistive devices.

3.2: Congress could increase funding for assistive devices through existing programs, extending coverage to devices that support independent functioning, but are not currently considered medically necessary, such as glasses, hearing aids, dentures, communication devices, lifeline devices, and devices to alter the home to compensate for functional impairments.

3.3: Congress could create a new program to supply assistive devices, modeled after programs currently in effect in Sweden.

3.4: Congress could fund a demonstration project to evaluate the efficacy of "Aids Centers" in providing and repairing assistive devices.

3.5: Congress could provide support for initiatives to improve the matching of individuals and devices, such as:

- *a. The use of assessment technologies to identify needs and appropriate devices.*
- *b. Training to increase understanding of the use of assistive devices among long-term care providers, including physicians, nurses, social workers, and staff at senior centers and nutrition sites. This could encompass training about the kinds of devices that are available, the effectiveness of devices in compensating for functional impairment, and appropriate referrals for patients who need devices.*
- *c. Training to increase awareness of the special needs of the elderly among professionals already involved in providing assistive devices, such as physical therapists and occupational therapists.*
- *d. Increased emphasis on services for the elderly through State rehabilitation agencies. (These agencies receive 80 percent Federal funding through the Rehabilitation Act of 1973.)*

3.6: Congress could fund a public education program targeted to the elderly and their families on the nature of functional impairments and use of assistive devices in compensating for impairment. Such a program could focus on countering negative attitudes about the use of assistive devices.

Issue 4: Should Congress support initiatives to increase the use of rehabilitation services for the functionally impaired elderly?

Options:

4.1: Congress could maintain current levels of support for rehabilitation services for the elderly. (It is expected that rehabilitation services will be provided more extensively because these services are exempt from Medicare DRGs.)

4.2: Congress could increase support for rehabilitation services through Medicare by eliminating restrictions on reimbursement for services that maintain functioning and limitations on the frequency of reimbursable services.

4.3: Congress could increase support for rehabilitation services through Medicaid by fiscal policies that encourage States to reimburse providers at higher rates.

4.4: Congress could mandate the provision of rehabilitation services in nursing homes as a condition for Medicare certification and encourage States to impose the same requirement for certification under Medicaid.

4.6: Congress could increase funding for training of rehabilitation professionals and other long-term care providers, including:

- *a. training to counter negative attitudes about the rehabilitation potential of the elderly,*
- *b. training in the use of assessment measures to identify the need for rehabilitation services, and*
- *c. training in techniques for rehabilitation of the functionally impaired elderly.*

4.7: Congress could fund a public education program targeted to the elderly and their families on the nature of functional impairment and the potential of rehabilitation services for improving functional capacity and compensating for impairments.

The use of rehabilitation technologies to compensate for functional impairment is limited by negative attitudes of the elderly, their families, and health care providers about the rehabilitation potential of those over 65, lack of training for providers, and limitations on reimbursement for services to maintain functioning and devices to compensate for functional impairment. Federal initiatives to increase training for providers and reimbursement for a wide range of rehabilitation technologies will increase use, resulting in improved functioning for many elderly individuals and decreased need for long-term care services. Demonstration of the effectiveness of these technologies can be expected to decrease negative attitudes that now restrict use.

Service delivery systems

Issue 5: Should Congress support initiatives to improve services delivery?

Options:

5.1: Congress could maintain current support for coordination of services at the community level including funding for Area Agencies on Aging and Medicaid waivers that allow case management as a reimbursable service.

5:2: Congress could create a federally funded case management system modeled after the Channeling Demonstration Program.

5.3: Congress could provide more flexible funding and other financial incentives to encourage the development and use of a comprehensive range of long-term care services provided by single agencies such as hospital and nursing home based service systems, S/HMOs, and life care communities.

5.4: Congress could consolidate Federal funding for long-term care services into a single program, combining funding from Medicare, Medicaid, the Title XX Block Grant, Title III of the Older Americans Act, and the VA.

The lack of coordination of Federal programs that fund long-term care is an important cause of fragmentation of services at the community level, but combining these programs into a single Federal long-term care program (option 5.4) would require major changes in legislation, regulations, and agency structures at the Federal, State, and local level. In the absense of these substantial changes, Federal support for systems to coordinate services at the community level can help to decrease fragmentation and improve access to appropriate services. Such systems include local provider groups, information and referral systems, case management, hospital or nursing home based service systems, S/HMOs, and life care communities.

Technical memorandum: Federal programs funding long-term care services

Medicare

Medicare, authorized by Title XVIII of the Social Security Act, pays for acute care services (hospitalization and physician's services, etc.) and some long-term care services for elderly and disabled beneficiaries. Almost all elderly persons are covered by Medicare.

Nursing Home: Medicare pays for up to 100 days of skilled nursing care within each benefit period with substantial copayments after the first 20 days. (A benefit period begins the day an individual is admitted to a hospital or nursing home and ends when he or she has been out of the hospital or nursing home for 60 consecutive days [25]). Custodial care is not covered. In 1980, Medicare paid $337 million for skilled nursing care for elderly individuals. This represented less than 1 percent of total Medicare expenditures and about 2 percent of all spending for nursing home care (126).

Board and Care Facilities: Not covered.

Home Care: Medicare funds skilled nursing care, physical therapy, speech therapy, occupational therapy, medical social services, and home health aide visits with the authorization of a physician.[27] Under Medicare regulations home health aides can provide personal care but can only perform homemaker services such as cleaning and changing beds when these services can be shown to prevent or postpone institutionalization. No chore services are provided. In 1978, a majority of the home care visits funded by Medicare were skilled nursing visits (55.7 percent), while 30.7

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[27] All home care services funded by Medicare must be authorized by a physician, and the physician is supposed to determine the extent and nature of all services provided. Nevertheless, a recent GAO study found that home care agencies were generally planning the services and most physicians were not aware of the services they had authorized. In fact, 50 percent of the physicians interviewed were not seeing the patients for whom they had authorized home care services, and very few physicians were aware of the cost of these services (116).

percent were home health aide visits, and 10 percent were physical therapy visits (116). Medicare regulations specify that home care services can be covered only when the recipient is homebound; it has been very difficult, however, to define homebound, and services have been funded for some elderly individuals who are able to leave home (116).

Medicare outlays for home care services increased from $287 million in fiscal year 1976 to $964 million in fiscal year 1981 (116), and the number of Medicare home care visits has doubled in the past 10 years; nevertheless, funding for home care services accounts for only about 2 percent of Medicare expenditures (118). There is no patient deductible for home care services under Medicare, so these services are free to the patient (116).

Adult Day Care: Medicare pays for skilled nursing, physical therapy, and occupational therapy provided in the adult day care setting, but does not cover adult day care as such.

Hospice: As of October 1, 1983, Medicare funds hospice care for terminally ill beneficiaries with a life expectancy of 6 months or less. Reimbursement has been limited to $46.25 per day per patient, but legislation to raise this amount was approved on November 9, 1984 (P.L. 98-617).

Respite Care: Medicare home health care services may be used by some families for respite care (116).

Congregate Housing: Not covered.

Medicaid

Medicaid is a Federal-State program authorized by Title XIX of the Social Security Act. It pays for acute and long-term care services for low-income individuals, including the elderly. Because regulations governing Medicaid programs are determined by each State, within the Federal guidelines, there are significant variations between States in eligibility requirements and available services. States can limit services to individuals with incomes below a set level or they can provide services for the "medically needy," i.e., individuals whose income is below the set level only *after* their medical expenses have been deducted.

Nursing Home: The Federal Medicaid program defines two types of covered nursing home care: skilled care, provided in a skilled nursing facility (SNF), includes services that are needed on a daily basis, must be provided in an institution, and require the skills of professional or technical personnel; intermediate care, provided in an intermediate care facility (ICF), is health-related care for individuals who require services that are above the level of room and board and must be provided in an institution. In the SNF, a professional nurse must be on duty 24 hours a day. In an ICF, a professional nurse must be on duty only during the day shift (25).

Although Federal regulations are quite specific, States vary greatly in their use of these two levels of care. Some States, like California and Connecticut, consider almost all the care they provide skilled care, while others, like Iowa and Oklahoma, provide almost all intermedicate care. Since it is unlikely that the types of care needed by nursing home residents varies greatly between States, variation in the use of the SNF and ICF categories probably results from differences in State policies that implement the Federal Medicaid regulations (25).

In fiscal year 1980, Medicaid paid $7.9 billion for nursing home care. This represents more than one-third of all Medicaid expenditures and about 45 percent of all spending for nursing home care (119). The Federal Government pays from 50 to 78 percent of State Medicaid costs for services and up to 50 percent of administrative costs. In recent years, Federal payments to the States have been capped at lower levels than previously (e.g., 96 percent of fiscal year 1982 dollars were available in 1983).

Board and Care Facilities: Not covered.

Home Care: Under Federal Medicaid guidelines, States are required to provide skilled nursing care and home health aide services, while other services such as personal care services, physical therapy, speech therapy, and occupational therapy are optional (25). Currently 18 States are covering personal care services including bathing, dressing, feeding, and some housekeeping services if related to a medical need (25). Services must by ordered by a physician, and home health aide services and personal care services must by supervised by a licensed nurse (138).

Medicaid expenditures for home care have been relatively low (1.4 percent of total Medicaid spending in fiscal year 1980) (25), and States vary widely in the extent to which Medicaid is used to fund home care services. In fiscal year 1980 New York accounted for 40 percent of all recipients nationwide, almost half of all Medicaid home care expenditures, and 90 percent of Medicaid expenditures for personal care (25). Medicaid payments for home care services are generally much lower than Medicare payments, and it is likely that the lower Medicaid reimbursement rates discourage providers from serving Medicaid recipients.

Medicaid 2176 Waiver Program: A 1981 amendment to the Social Security Act waived some of the requirements for Medicaid-funded home care services, allowing States to set up demonstration projects to offer home and community-based services not previously paid for by Medicaid. Services provided through the 2176 waiver program could be offered on less than a statewide basis, so that projects could be set up in certain geographical areas and targeted to specific groups of recipients. Waiver projects must be approved by the Secretary of Health and Human Services, and total spending must be no higher than without the waiver project. Medicaid waiver applications approved by mid-1983 include 26 programs for the elderly, and many of these programs include home care services: 16 programs include homemaker services, 11 include personal care, 7 include home health care, and 5 include chore services (138).

Adult Day Care: Adult day care is an optional Medicaid service, and as of fiscal year 1984, eight States provided Medicaid reimbursement for adult day care. Several States provide adult day care through the 2176 waiver program (25,127).

Hospice: Hospice care is not currently funded by Medicaid, but New York State has requested an administrative decision by the Health Care Financing Administration to make reimbursement available under existing legislation.

Respite Care: Home care services covered by Medicaid are used by some families for respite care.

Congregate Housing: Not covered.

Title XX

Title XX of the Social Security Act was converted to "Title XX Block Grants to States for Social Services" in 1981 (118). Title XX grants are used by States primarily for social services for elderly and nonelderly individuals, and there is considerable variation between States in services provided.

Nursing Home: Not provided.

Board and Care Facilities: Some States provide limited funding for geriatric foster care with title XX funds (25).

Home Care: Home care services provided in some States with title XX funds include homemaker, chore services, and home-delivered meals, but GAO has estimated that in the States they studied, less than 13 percent of title XX funds were spent for these home care services (25). It is difficult to specify what percentage of title XX home care services were used by elderly persons, but one author has estimated that in fiscal year 1980 between $723 million and $1.593 billion in title XX funds were spent on long-term care services for the elderly. States vary widely in the use of these funds. For example, it is estimated that California spent about 40 percent of all title XX funds for long-term care (25).

Adult Day Care: Although more than 95 percent of publicly funded adult day care was paid for with title XX funds in fiscal year 1980, and almost all States provided some adult day care with title XX funds, total title XX expenditures for adult day care were relatively limited. It is estimated that less than 3 percent of all title XX expenditures for long-term care for the elderly were spent on adult day care (25).

Hospice: Not covered.

Respite Care: No information available.

Congregate Housing: Housing subsidies are not provided, but services for residents on congregate housing facilities are provided with Title XX funds in some jurisdictions. Examples include homemaker and transportation services.

Title III

Title III of the Older Americans Act provides funds for a variety of services for the elderly, including home-delivered and congregate meals, transportation, homemaker, and home health aide services. The Administration on Aging allocates title III funds to States primarily on the basis of the proportion of the State's population aged 60 and over compared with the proportion of that age group in the national population (25).

Nursing Home: Not covered.

Board and Care Facilities: Not covered.

Home Care: Home care services funded through title III include home-delivered meals, shopping and escort services, telephone reassurance, homemaker, home health aide, and residential repair (25). The GAO estimates that $43 million of title III funds were spent on home care services for the elderly in fiscal year 1980 (118).

Hospice: Not covered.

Respite Care: Home care services provided with title III funds are used by some families for respite care. In addition, some localities provide specific respite care services with title III funds. No accurate figures are available on spending for respite care nationally.

Congregate Housing: Housing subsidies are not provided, but services for residents of congregate housing facilities are provided with title III funds in some jurisdictions. Examples include congregate meals and recreation services.

Supplemental Security Income (SSI)

SSI is the Federal program enacted in 1972 to provide minimum monthly payments to aged, disabled, and blind individuals who have incomes below the minimum standard. Since SSI is a cash benefit, it can be used by recipients to pay for long-term care services, but low benefit levels limit the kinds of services that can be purchased.

Nursing Home: Not covered. When SSI recipients are admitted to a nursing home, their SSI grant is reduced to a maximum of $25; if they have other income, the SSI benefit is reduced to zero.

Board and Care Facilities: Many residents of board and care facilities receive SSI payments and use this income to pay for their care. In addition, States are allowed to supplement the Federal minimum SSI benefits, and by 1983, 34 States and the District of Columbia provided supplements specifically for persons living in board and care facilities (52,131).

Home Care: Not covered.

Adult Day Care: Not covered.

Hospice: Not covered.

Respite Care: Not covered.

Congregate Housing: Not covered.

Veterans Administration (VA)

The VA provides a wide range of long-term care services for eligible veterans. The complex eligibility criteria for services are not discussed here.

Nursing Home: In fiscal year 1982, about 15,000 veterans were cared for in VA nursing homes with an average daily census of about 8,400 (132a). About 62 percent of these individuals were 65 or over (80). In addition, about 31,500 veterans were paid for in non-VA community nursing homes with an average daily census of about 9,500 (132a). About 56 percent of these individuals were over 65 (80).

Board and Care Facilities: The VA operates 16 large board and care facilities with an average daily census of about 7,000. In addition, the VA places veterans in smaller board and care homes. In fiscal year 1982, approximately 13,500 veterans were living in about 3,000 supervised board and care homes: approximately 30 percent were over 65 (132a). (State veterans homes also provide domiciliary care and some nursing home care.)

Home Care: The VA provides home care services to homebound veterans through 30 VA medical centers. In fiscal year 1983 it was estimated that medical, nursing, social, and rehabilitation services would be provided for about 5,600 veterans. Veterans who do not live near one of the 30 medical centers do not have access to VA-funded home care services.

Adult Day Care: Recent legislation authorizes VA provision of adult day care through VA facilities or through contracts with non-VA providers.

Hospice: The VA operates one hospice program in Los Angeles (80).

Respite: VA home care services are used by some families for respite care.

Congregate Housing: Not covered.

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Chapter 8

Health Care Costs and Access to Technology for Older Persons

Contents

Page

Introduction 249

Health Spending of Young and Old 251

Technology, Aging, and Other Factors Affecting Health Expenditures 252

Selecting Appropriate Technologies for Older Persons 257

Appropriate Care 257

Use of Health Care Technologies 258

Appropriate Providers 259

Cost-Containment Strategies 259

Federal and State Efforts to Contain Costs of Institutional Care 261

Capitation Approaches 263

Technology and Coordination of Federal Health Programs 263

Federal Health Programs 264

Hospital Backup 264

Information Technology for Coordination of Health Programs 266

Financing Alternatives for Health and Long-Term Care 266

Findings and Conclusions 268

Research Priorities 269

Congressional Issues and Options 270

Chapter 8 References 272

Tables

Table No. *Page*

18. Average Annual Compound Rates of Growth of Benefits and Enrollees, Fiscal Years 1978-82 254

19. Factors Accounting for Growth in Expenditures for Selected Categories of Total Systems Cost, 1971-81 255

20. Relative Contribution of Different Factors to the Total Increase in Real Expenditures for Physician Services 256

21. Average Utilization of Health Services by Elderly Medicare Beneficiaries, by Type of Supplementation 260

22. Formal Long-Term Care Expenditures in Hospital Care Nursing Home Care, and Community-Based Care, by Source of Funds 265

Figures

Figure No. *Page*

24. Percentage Distribution of Personal Health Care Expenditures by Source of Funds and Age Group, Calendar Year 1978 252

25. Per Capita Personal Health Care Expenditures for the Aged, by Source of Funds and by Type of Care, Calendar Year 1978 252

26. Factors Accounting for Growth in Total Health Costs, 1971-81 253

Chapter 8

Health Care Costs and Access to Technology for Older Persons

Introduction

Health care costs, including long-term care expenditures, have grown rapidly over the last three decades, increasing from $12.7 billion (4.4 percent of gross national product (GNP)) in 1950, to $322.6 billion (10.5 percent of GNP) in 1982 and an estimated $357 billion in 1983. Total health care expenditures are projected to reach 12 percent of GNP by the year 2000 or sooner (10,15). Growth in per capita health care costs, augmented by the growth in numbers of the U.S. population over 65, has produced an impending crisis in the funding of Medicare and Medicaid, major payers for health service to the elderly.

Technological development in recent decades has increased the effectiveness and sophistication of health care. It has also increased its costs. The relationships between cost, technology, and financing are complex, in some cases not well understood, and require continuing investigation. Although new medical technologies[1] have raised the cost of care—by expanding the types of problems that can be diagnosed and treated—they have also provided more efficient strategies for the management of acute and chronic disease and functional disability. Depending on how it is applied, the same technology can be either cost-saving or cost-enhancing. Exercise electrocardiography, for example—a noninvasive diagnostic test for coronary heart disease—can be cost-saving if it is used to screen candidates for invasive diagnostic evaluation, thereby reducing the number of invasive tests. If it is simply added to the diagnostic workup for patients for whom invasive testing is already planned, it increases the cost of care. The net effect of technology on the cost of care therefore depends on both the technology and the ways in which it is used.

If the growth of health expenditures can be contained at levels comparable to the general rate of inflation, these expenditures will halt their encroachment on the Nation's resources. How much health care is enough, who is responsible for paying, to what extent equality of access should be assured, and other ethical questions combine with questions of necessity and appropriateness to create an exceedingly complex set of issues that apply to all age groups of consumers and all payers for care. This chapter emphasizes issues related to technology and the aging of the U.S. population in the context of the demand for fiscal restraint.

Control of escalating health care spending is a priority in light of current and projected Federal deficits as well as the growing costs of employee health plans and personal expenditures for care. Because those over 65 use more health services than any other age group and the Federal Government has assumed significant responsibility for funding these services, the kinds and costs of care for the elderly are a particular congressional concern. Instituting effective controls over costs of covered benefits as well as total health spending thus deserves increased attention.

Congress has paid some attention to slowing the growth of these costs. Direct attention has been given to controlling Federal expenditures for Medicare and Federal contributions to Medicaid. Total savings may be reduced by cost shifting to third-party payers and individuals, or from one Federal program to another. Entitlement programs are primary concerns because their costs are less easily controlled than other Federal health activities.

Access to health-related technologies—for those over 65 and for the poor of all ages—has also been a major congressional concern. Recognizing that the cost of technologies can be a strong deterrent to their availability and use, Congress has legislated programs to assist these people with the purchase of health care. Medicare is the largest Federal health care financing program. Medicaid is a federally aided, State-run, means-tested (eligibility based on income) program that provides health benefits for the categorically needy, including the poor elderly. The Veterans Administration (VA) provides resources for the care of older veterans. In addition, the Federal Government provides funding for health resource programs (e.g., block grants to States, health planning) designed to improve the distribution, supply, and cost effectiveness of these services.

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[1] OTA defines medical technologies as drugs, devices, and medical and surgical procedures used in medical care, and the organizational and support systems within which they are produced.

Federal policy for health and long-term care has in part shaped the development of technology, the settings in which it is used, and access to it for those over 65. The rate of adoption, and hence the availability of a new technology, is strongly influenced by whether or not it is eligible for reimbursement and whether it is regulated by health planning activities. Because reimbursement has been more liberal for inpatient procedures, hospital-based care has been encouraged. Recent changes have encouraged more outpatient diagnostic and surgical procedures. The implementation of prospective payment under Medicare, as discussed earlier and in this chapter, may shift the more acutely ill patients and the technologies for their care to outpatient clinics, nursing facilities, and home care settings. More sophisticated technology and personnel may thus be required in these settings which, in turn, may increase the cost of care in them.

Because Federal payments for health care represent about one-third of total hospital revenues, one-third to one-half of physician payments, and about half the cost of long-term care, changes in Federal reimbursement strategies may induce changes in the use of technology throughout the health care system. To the extent that other payers do not adopt similar strategies and providers are able to maintain full practices without participating in Federal programs, older persons who depend on these programs may suffer reduced access to health care technologies. Even under cost reimbursement policies for acute care, a number of technologies are identified elsewhere in this report that would be beneficial to the over-65 age group but may be currently underutilized. This results, in part, because of their cost and the lack of reimbursement under Federal and State programs. Coverage for additional services could increase overall costs, but there is potential for limiting the increase by achieving greater functional independence.

Federal and federally assisted State programs provide acute and long-term care for the elderly. Medicare, Medicaid,[2] income support programs, services through block-granted programs, and VA programs are among the efforts to provide care for those over 65. Using these benefits to access the proper mix of acute and chronic health care, as well as appropriate supportive and social services, can be difficult. Lack of continuity of services can sometimes lead to inappropriate and poor quality of care and increased costs due to duplicated services and the loss of functional independence.

A number of observers have identified mismatches between Federal and private health benefits and the needs of an aging population (9,39,40). The success of the Medicare program in providing access to acute care technologies has contributed to the recent declines in mortality for those over 65. However, as noted in chapters 2 and 3, decreasing mortality has not been accompanied by comparable declines in *morbidity* in the older population, and the elderly therefore carry a larger burden of illness (36). Growing numbers of older individuals with multiple health problems will continue to increase the demand for technologies to prevent and manage chronic disease and for long-term care (10,14). Policymakers focusing on cost containment must recognize that the changing needs of the population served by Medicare have increased Medicare costs and stimulated spillovers into other Federal programs, most notably Medicaid. This mismatch between needs and benefits has resulted in increased out-of-pocket spending by individuals as well. Increased costs may deter older users from seeking needed care for correctable problems (e.g., blood-pressure control, vision problems, and routine health evaluations for chronic disorders), potentially resulting in greater ultimate costs for acute and restorative care.

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[2] Many older persons requiring long-term care come to depend on Medicaid benefits by "spending down" enough to become eligible, i.e., by liquidating assets and exhausting their finances on high-cost, long-term care.

The financial burden of long-term care is a particularly severe problem for those over 75 because the risk of needing prolonged care increases with age. Few benefits are provided by Medicare, and private insurance is largely unavailable to protect against this eventuality. Medicaid is the only safety net and provides benefits only after personal resources are exhausted. Depletion of resources may have the additional effect of eliminating future opportunities for community care. Should a patient's condition improve or the availability of new technologies permit a transition, the patient might no longer have a residence or lack the means to be financially independent.

This chapter provides an overview of factors affecting health expenditures and cost-containment efforts. Included are a comparison of spending by those over 65 and by younger age groups; the contribution of technology, aging, and other factors to growth in health care costs; the goals for appropriate use of technology; the characteristics of older health care consumers that influence their use of services and technologies; cost-containment activities and some of their implications for cost and quality of care; and the need for better coordination among Federal programs. The hospital backup problem is explored as an example of the impact of poor coordination on costs and quality of care. The potential for better access to information as a means to improve coordination and outcomes is also discussed. The major issues are then detailed, and options are presented for congressional consideration.

Health spending of young and old

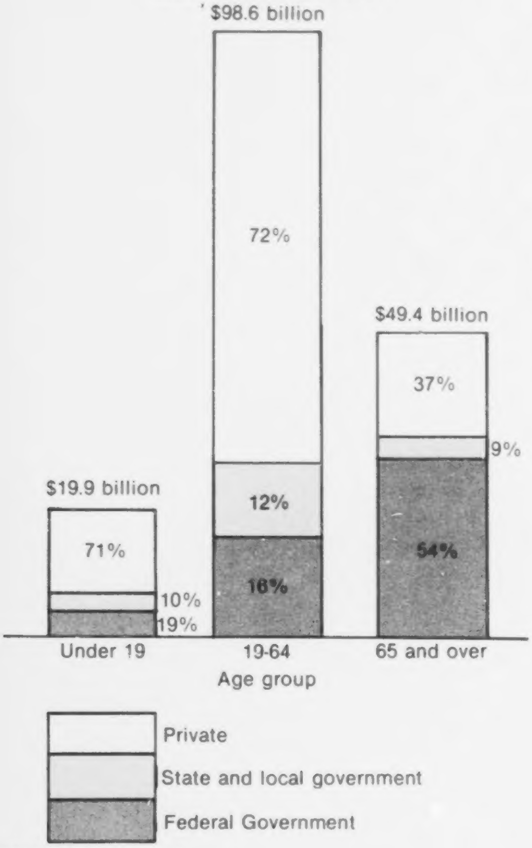
Health care spending differs significantly among various age groups. In 1978, those under 19 (31 percent of the U.S. population) accounted for 12 percent of the $168 billion health care expenditure, while those 19 to 64 (58 percent of the population) accounted for 59 percent, and those over 65 (11 percent of the population) accounted for 29 percent of the total. This higher per capita spending by older age groups results from increased contact with the health care system and an increased number of services required per visit.

Sources of payment also differ by age group. Public and private health benefits provided by government, industry, and direct purchase of insurance have grown for all age groups. Private insurance and personal expenditures are the major sources of payment for younger persons (about 70 percent), while government (Federal, State, and local) finances the greater proportion of the care provided for those over 65 (about 63 percent) (14), as shown in figure 24.

Hospital care represents the major expenditure for all age groups, but its relative importance increases with age. Physician services rank second to hospital care for younger persons and third after hospitals and nursing homes for the older population. Nursing home use is dominated by those over 65, and represents one-fourth of total health expenditures in this age group. Dental visits consume a smaller proportion of the health care budget for those over 65, but the average charge is higher than for those under 65. Annual per capita expenditures for prescription drugs and sundries increase threefold between the under-19 age group ($41) and the over-65 age group ($133) (14).

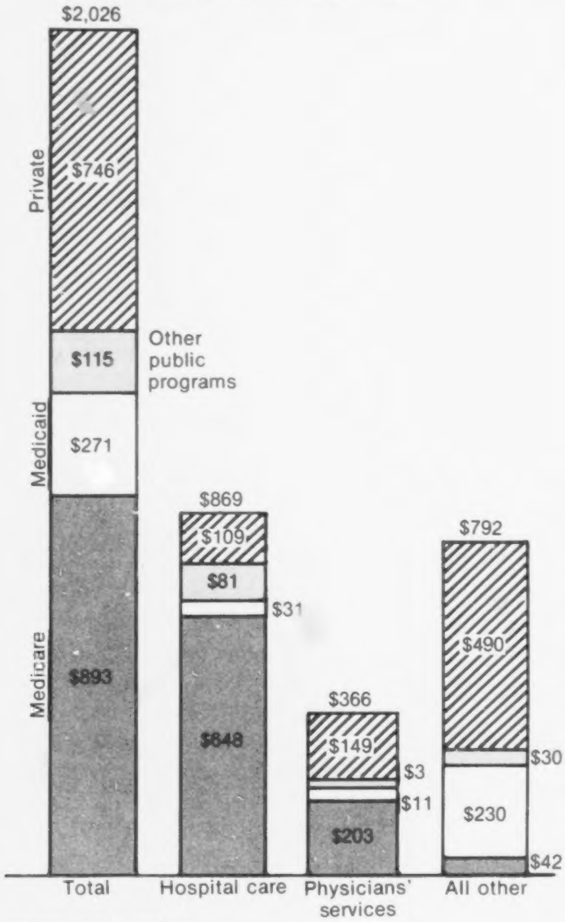
The growth of the older population will continue to exert pressure on Federal programs, but acceleration of health spending is a problem for individuals of all ages, their insurers, and their employers. Although Medicare and Medicaid provide an important subsidy affording some financial protection for the elderly, these programs do not eliminate the need for significant out-of-pocket outlays (see fig. 25). Many necessary services, such as eyeglasses, hearing aids, and extended nursing home care, are not covered by Medicare. Also, private supplemental ("medigap") insurance to cover deductibles is purchased by more than

Figure 24.—Percentage Distribution of Personal Health Care Expenditures by Source of Funds and Age Group, 1978



SOURCE: Fisher, 1980 (14).

Figure 25.—Per Capita Personal Health Care Expenditures for the Aged, by Source of Funds and by Type of Care, 1978



SOURCE: Fisher, 1980 (14).

63 percent of the elderly, and another 14 percent receive Medicaid assistance (21). The value placed on protection against health expenses is underscored by the fact that personal income does not correlate with insurance premiums paid. In 1981, the out-of-pocket per capita expenditure of $914 for health services (excluding costs for insurance premiums) by those over 65 represented 11 percent of their per capita income. Recent estimates indicate that this proportion may reach 14 or 15 percent in 1984.

Technology, aging, and other factors affecting health expenditures

Much attention has been given to the increase in demand for health services resulting from the growth in the older population, especially the growth in numbers of those over 75. The elderly need and use more medical services. Yet the growth of this high-risk group accounts for only a *small amount* of the increase in total personal health care expenditures. Most of this increase has been brought about by general inflation; the increased cost of capital, labor, and supplies; inflation of medical care prices in excess of general inflation; and changes in the types and quantities of services provided—"service intensity"—often used as a proxy measure for increased technology (11,15,46,48). Intensification of services includes not only the introduction of new technology but also increased labor intensity and more frequent use of existing technology. This section explores the contribution of technology and aging of the population relative to other factors fueling the growth of health expenditures.

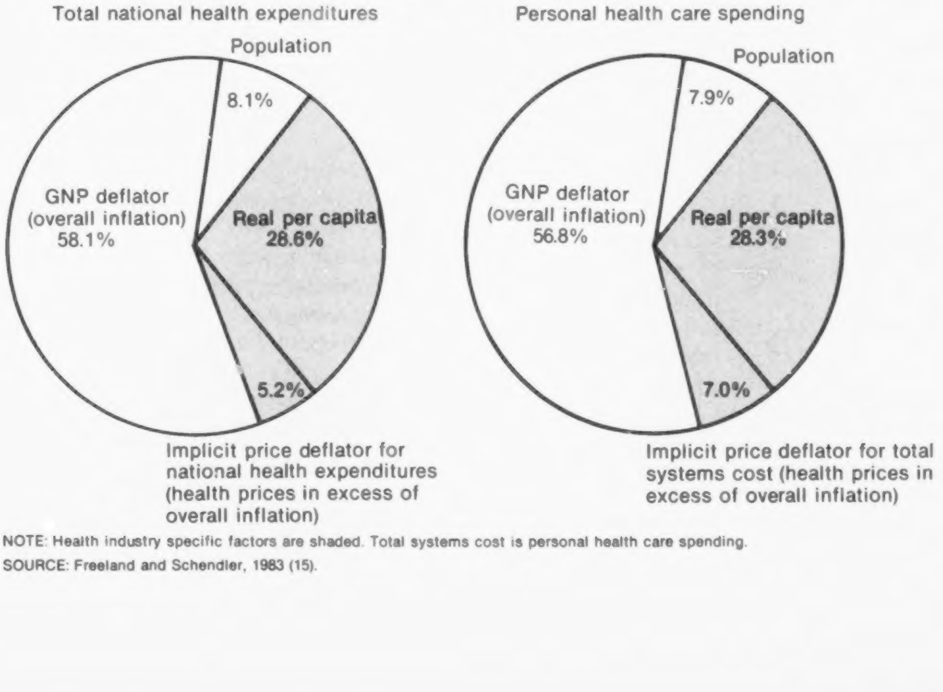
Among the economic, policy, and social factors to which analysts have attributed the growth in real spending (15,37,46,48) are:

- payment mechanisms:
  - —third-party payers that insulate patients and physicians from true patient costs, and
  - —fee-for-service and cost-based reimbursement methods that lack incentives to control costs;
- technological innovation:
  - —product innovations that expand range of services, and
  - —process innovations that can increase costs and quality of care;
- increased use of existing technology;
- population factors:
  - —shifts in age-sex characteristics,
  - —increases in real income, and
  - —psychological factors such as the value of good health and a reluctance to forego heroic care; and
- health resources:
  - —cost and supply of facilities,
  - —cost and supply of equipment, and
  - —cost and supply of manpower.

An analysis of health expenditures and costs between 1971 and 1981 shows that real increases in services accounted for 28.6 percent (fig. 26) of the increase in expenditures during that period (15). In specific terms, a recent study by the Congressional Budget Office found that the major increase in program outlays was due to increased benefits *per user* rather than to either increased enrollees in the program or increased proportions of those enrollees receiving services (table 18). Some of the increase in per capita costs reflects a growing burden of care due to the aging of the population (37 percent of those enrolled in Medicare were over 75 in 1966; this proportion rose to 41 percent in 1979), but utilization rates increased significantly even in the same age group (e.g., a 27-percent increase in hospital discharge rates in enrollees 65 to 66 between 1967 and 1976), suggesting higher utilization rates overall (45).

Medical technology is the primary factor in the increase in health expenditures. Analyses of the impact of medical technology on health care costs can be addressed in the aggregate or from a tech-

Figure 26.—Factors Accounting for Growth in Total Health Costs, 1971-81



NOTE: Health industry specific factors are shaded. Total systems cost is personal health care spending.

SOURCE: Freeland and Schendler, 1983 (15).

Table 18.—Average Annual Compound Rates of Growth of Benefits and Enrollees, Fiscal Years 1978-82
(In percent)

	Aged enrollees	Disabled enrollees[a]	All enrollees
Hospital insurance:			
Total benefits	18.4	19.3	18.5
Number of enrollees	2.3	1.7	2.2
Proportion of enrollees receiving reimbursement ...	2.1	1.1	2.0
Benefits per user ...	13.4	16.1	13.7
Supplementary medical insurance:			
Total benefits	20.7	24.0	21.2
Number of enrollees	2.3	2.2	2.2
Proportion of enrollees receiving reimbursement ...	2.9	2.0	2.9
Benefits per user ...	14.7	19.0	15.3

SOURCE: Congressional Budget Office, 1983 (45).

nology-specific perspective. The aggregate analysis is useful although it ignores the patient benefits derived from technological innovation. The technology-specific approach is helpful in establishing the cost effectiveness of a particular technology or class of technologies but ignores the overall impact on systems costs. Both kinds of analyses are important in assessing the structure and funding of health and long-term care. A recent OTA study on technology and the Medicare program (48) found that in the aggregate, technology-related factors—more services per enrollee and the increase in costs of those services in excess of general inflation—accounted for about 30 percent of the growth in Medicare costs per enrollee between 1977 and 1982. These factors—service intensity and excess medical price inflation—are influenced by other factors as well as technology. At best, they provide an oblique view of the impact of technology on costs of care.

Even recognizing the limitations of aggregate techniques and that available reports encompass all age groups, an analysis of total personal health expenditures is useful for evaluating the differential effects of technology and population factors on expenditures for hospital care, physician services, dental services, and nursing home care (table 19). General inflation accounted for about 50 percent of the increase in all categories of service. The technology-related factors discussed above accounted for about 35 percent of the increase in expenditures for hospital care and physician services, but less than 20 percent of the increase for dental care and nursing home services.

Utilization factors are related to population aging, reflecting older Americans' increased burden of illness, and to other factors that induce demand, as discussed later in the sections on cost containment and consumer characteristics. Aggregate population growth has been constant across different services, as would be expected, at about 7 percent. Per capita visits exhibit wide variability, ranging from −3.4 percent for physician visits to +18 percent for hospital outpatient services to +20 percent for nursing homes. Because these statistics reflect the net effect for all age groups, differences in utilization trends for different age groups should be noted. Visits to physicians and hospital discharges have been decreasing for younger age groups. Physician visits for persons over 65 have remained relatively constant while hospitalization rates, measured by both surgical and total discharges, have been increasing. Average lengths of stay have been decreasing for all age groups but remain longer for those over 65. The relative importance of the utilization-related factors would thus be greater in the over-65 age group.

The increase in costs for physician care between 1970 and 1979 was analyzed from a different perspective (37). The effect of technology was calculated indirectly as the residual, after accounting for other factors thought to be causally related to expenditure increases.[3] This residual was 11 percent (see table 20). Population aging was considered directly and accounted for 15 percent of the increase, due to increases in the size of high-risk groups such as the very old. Variables which influence demand for and access to care—physician-population ratio and insurance for physician services—accounted for 40 percent of the increase.

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[3] The independent variables selected for this regression study emphasized factors that might cause changes in health spending. The studies by Freeland and Schendler (15) and by (48). OTA decomposed expenditures into their component parts rather than attempting to identify causal factors. This illustrates the influence of underlying assumptions in these types of analyses.

Table 19.—Factors Accounting for Growth in Expenditures for Selected Categories of Total Systems Cost, 1971-81[a]

Factors accounting for "how" medical care expenditures rose	Community hospital care			Physicians' services	Dentists' services	Nursing home care excluding ICF-MR	Total systems cost (personal health care)
	Inpatient expenses[b]		Outpatient expenses[b]				
	Inpatient days	Admissions					
Economy-wide factors:							
1. General inflation	51.7%	51.7%	41.6%	58.1%	58.6%	53.0%	56.8%
2. Aggregate population growth	7.2	7.2	5.6	8.1	8.2	7.4	7.9
"Health-sector specific" factors:							
3. Growth in *per capita* visits or patient days	4.2	8.6	17.9	-3.4	14.2	19.8	NA
4. Growth in real services per visit or per day (intensity)	25.2	20.8	25.3	27.4	17.6	13.1	NA
5. Medical care price increases relative to general price inflation[c]	11.7	11.7	9.6	9.8	1.4	6.7	7.0
Addenda: Growth in real services *per capita*	—	—	—	—	—	—	28.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NA = Not available.

[a] Total systems cost is called personal health care in Gibson and Waldo (1982).

[b] Community hospital expenses are split into inpatient and outpatient expenses using the American Hospital Association (1982) procedure.

[c] See table A-13 for price variables.

SOURCE: Freeland and Schendler, 1983 (15).

Table 20.—Relative Contribution of Different Factors to the Total Increase in Real Expenditures for Physician Services, 1970-79

Factors	Percent increase
Physician-population ratio	22
Total population growth	19
Age distribution of population	15
Insurance for physician's services	15
Per capita income	9
Specialty mix	1
Prices of practice inputs (other than M.D.)	8
Residual (technology)	11
Total	100

SOURCE: Adapted from Sloan and Schwartz, 1983 (37).

An analysis of the growth in the use and costs of home care showed that the average rate of increase in expenditures was 31 percent *per year* from 1971 to 1980. This increase is attributable to the growth in the number of individuals served (59 percent), increases in the number of visits for those served (7.4 percent), and rises in costs and charges for each visit (39.1 percent). Older patients use home health services at higher rates (34.8 per 1,000 v. 23.4 per 1,000) but received fewer visits (23.1 visits per person v. 26.1 visits per person) compared to the disabled (51). The increase in the number of persons served is in part due to the increased numbers of persons needing care, but is also strongly influenced by the growth in the number of home care agencies and changes in reimbursement policy. Although costs and charge increases are the technology-related elements, they also reflect a number of factors unrelated to technology.

The availability of home care is clearly an influential factor. There were 3,959 home health agencies certified to receive Medicare reimbursement as of June 1983. These include Visiting Nurses Associations, official health agencies (State and local government), hospital-based programs, proprietary agencies, private nonprofit programs, and rehabilitation and skilled nursing home-based programs.

Home care is likely to continue to grow and become more sophisticated with home health agencies, hospitals, and nursing homes diversifying to include more comprehensive outpatient services, including medical equipment for home use, particularly as reimbursement policy encourages earlier hospital discharges. New Federal policies during the last two decades have encouraged this growth. They include (34):

- 1965—Medicare/Medicaid bills were enacted that provide limited home health care reimbursement.
- 1968—Home care was required as an alternative to skilled nursing home care for Medicaid participation.
- 1972—The coinsurance requirement for Medicare Part B was eliminated.
- 1980—Medicare dropped the requirement for prior hospitalization and eliminated the limit on the number of visits deductible.
- 1982—The Tax Equity Financing Reform Act (TEFRA) permitted reimbursement for some hospice care.
- 1983—Prospective payment for hospital care was enacted and encouraged earlier discharges.

This brief review of several analyses of the growth in health spending illustrates the difficulty in establishing quantitative estimates of the causal factors and their relative importance. Different conclusions can be reached, depending on the technique and the variables selected for analysis. These studies do establish that technical innovation, increased utilization due to greater need, and increased access are major components. Technology appears to be more important in the acute medical care arena, whereas utilization factors have been more important in long-term care, including nursing homes.

Dental care is an interesting special case in considering the impact of technology, relative to other factors, on cost of care. Expenditures for dental care grew at an annual rate of 13.1 percent during the 1970s, reflecting increased per capita utilization, new technical innovations such as high-speed drills, and growth in complex orthodontic and periodontal procedures. Yet inflation in dental prices contributed only 1 percent to the increase, even though the dental Consumer Price Index (CPI) increased at an annual rate of 7.6 percent; price inflation in both hospital care and physician services was much higher. This suggests that dentists absorbed a greater proportion of the increased cost of operation.

Dental services are financed in large part by out-of-pocket expenditures, although dental insurance benefits are rapidly expanding. The absence of third-party reimbursement and an ample supply of dentists to allow competition have been suggested as reasons for lower price inflation for this service. Better productivity (high-speed drills increase the number of cavities that can be filled per visit), the effectiveness of fluoridation, and other preventive dental procedures may also have contributed to constraining cost growth (13,15, 26,29).

Employee health plans are currently adding dental benefits. In some cases, dental benefits are being substituted for mental health benefits (used by fewer beneficiaries); this spreads benefit outlays over more beneficiaries (Employees Benefit Plan Review, 1981, cited in 15). Older persons who depend on Medicare as their primary health insurer may thus enter the system with better dental health and practices, but also may be accustomed to greater insurance coverage, which could increase the pressure to add dental benefits or create a market for dental insurance in this population.

The benefits of improved access to health technologies for those over 65 have occurred primarily as a result of the enactment of Medicare and other Federal programs. In 1966 medical care—particularly hospitalization—became affordable to many older persons for the first time. Their initial demand for hospitalization displaced younger persons until additional capacity was built. Inpatient care has continued to grow while physician visits have remained fairly constant, partly in response to reimbursement policy.

The challenge is to find the most efficient technologies as well as the most effective. Technology-specific approaches are most useful for this task, but the results must be effectively applied to achieve the goal of improved efficiency. OTA studies have assessed the impact of specific technologies and stressed the importance of assessing both their costs and benefits. Case studies on technologies for hearing impairments and managing incontinence are being published in conjunction with this report. Additional case studies on preventive, diagnostic, and therapeutic technologies such as cervical cancer screening, X-ray procedures, and joint replacement have also been done (see 47).

Selecting appropriate technologies for older persons

Appropriate care

Consensus about the goals of care for older persons is important in considering how to contain costs and also in setting performance objectives for the care system. Geriatricians have begun to focus on what constitutes appropriate care for those over 65, which will influence the selection of technologies and the settings in which they are used. The factors that influence selection of appropriate care include the following (19,38):

- emphasis on preservation and restoration of functional ability,
- building and maintaining a support system,
- broadened approach to health assessment,
- application of appropriate medical care for acute and chronic disease,
- acceptance of the legitimacy of death,
- allowance of sufficient time for recovery,
- attention to care in the least restrictive environments, and
- continuity of care, including health and social services.

The geriatrician's primary concern is not economy, but appropriateness. Appropriateness may, in fact, lead to economy as long as cost controls are considered simultaneously. The original goals of the Medicare program were developed to address problems in access to services and technology for older Americans who were inadequately served by private insurance. The focus on access problems gave rise to the cost-reimbursement approach that, in part, has fueled the rise in costs of care and in some cases the inappropriate application of technology. The elderly are again unprotected against certain expenditures for needed care. Policy alternatives must seek to balance concerns for access and quality with efficiency and economy as incentives for developing health care and health financing technologies. The ways in which older consumers use services must also be considered. Appropriate utilization is a key factor in maintaining fiscal solvency and quality of care.

Use of health care technologies

Demand for and access to health care technologies by older consumers are influenced by physical and psychosocial factors as well as economic factors. These factors are important in understanding how clients respond to care providers' recommendations. They are also important in evaluating cost-containment schemes designed to reduce overutilization of health care services by the elderly. Cost-containment strategies that shift costs too heavily to older patients can cause many of them to delay care. Long delays can result in increased disability and higher costs, but overutilization will increase costs and not improve outcomes. Providers must recognize these factors in responding to older patients and selecting technical interventions. Some of the factors are age-based and can be expected to grow in importance in future cohorts of older persons. Others may be related to experiences and opportunities that can change dramatically in future cohorts due to general trends or specific educational efforts.

The clinical nature of illness in geriatric patients is different. Some diseases occur only in the elderly and classic symptoms may be replaced by nonspecific problems such as refusal to eat, falling, incontinence, dizziness, acute confusion, and weight loss or failure to thrive. The chronic nature of diseases and the frequency of multiple disorders are also important in this age group (3).

Photo credit: Jack Delano

Older persons often do not report health problems and may delay seeking treatment for a variety of reasons.

The nature of some diseases makes their symptoms difficult to distinguish from generally accepted effects of aging. In addition, nonphysiologic factors such as the older person's perceived seriousness of symptoms, denial of illness, alternative explanation of symptoms (e.g., just getting old), and access to treatment influence the decision to seek or delay care (2,25). Several studies have shown severe underreporting of symptoms by older persons (1,3,4,22,56).

Underdiagnosis of correctable functional (both physical and mental) and medical problems in the elderly is supported by the recent experience of the Geriatric Assessment Units, which have found an average of three correctable problems per patient (18). Many of the conditions identified in these studies do not require sophisticated diagnostic technology, but could be identified with careful evaluation of symptoms. This burden of unreported illness supports the validity of studies reporting delayed care-seeking behavior of the elderly (3,8,41). Older persons seem less likely to exaggerate their health problems than younger persons, and their complaints are more likely to be based on important underlying diseases.

The response of health professionals may reinforce the patient's denial of and failure to report functional disabilities. Health professionals may focus on specific diseases, rather than the functional status, of an older individual. Vision, hearing, and dentition problems are examples of neglected areas in primary care. The 1971-75 Health and Nutrition Examination Survey (HANES) found those 56 to 74 were more likely to receive an EKG or chest X-ray but were less likely to have a vision or hearing test than younger persons. Anecdotally, older patients complain that health professionals fail to listen and follow up on their specific functional complaints (18).

Appropriate providers

In addition to appropriate goals of care and appropriate consumer response, the types of providers may influence the cost, selection of technologies, and the efficacy and efficiency of care. The team care approach is accepted as the ideal strategy. Members of the care team that must respond to the broad spectrum of needs for the frail elderly can include physicians, nurse practitioners, physician assistants, nurses, social workers, occupational therapists, physical therapists, speech therapists, and home health aides. These providers can also be specially trained in the care of geriatric clients.

The impact of team care on the cost of care is influenced by management of the care team, the range of specific client problems, and the casemix that exists within a particular care setting. In general, highest efficiency can be achieved by matching patient needs with the least expensive provider having the requisite skills. The actual cost saving can be eroded by administrative costs of using additional providers and, as with technologies, other provider services can be additive rather than a substitute for more expensive care.

Skills, licensure, legal requirements, and communication among team members must be carefully considered to assure maximum efficiency. Cross-training of certain geriatric providers may be one approach to providing care more efficiently. For example, if a particular client's primary needs are for social services but there is also a need to monitor or administer medication, an appropriate training program might be designed to certify some social workers to carry out this function. Nurses already provide some social service assistance while providing nursing care. Training programs to enhance these skills might improve the efficacy of intervention.

Cost-containment strategies

A number of approaches focusing on economic incentives for consumers and providers, controlling prices, assuring appropriateness of care, and limiting expansion of facilities and services have been tried or discussed for controlling health care expenditures (43,45,48,49). These include:

- direct price controls,
- changes in reimbursement strategies from cost-based to various types of prospective payment,
- utilization review programs and Professional Standards Review Organizations to review the appropriateness of care,
- health planning and certificate-of-need programs designed to control capital expenditure,

- use of coverage policy to limit reimbursement to effective technologies,
- increased cost-sharing and coinsurance for Federal program beneficiaries to discourage "overutilization,"
- stimulation of more competition among health care providers and insurance plans, and
- contracting and preferred-provider approaches to channel patients to lower cost providers.

Regulatory actions have been the principal approach to cost containment to date. Capping payments (e.g., Economic Stabilization Program, Section 223) has not controlled long-term cost increases. The diagnosis-related group (DRG) case-mix approach (Public Law 98-21) for prospective payment has recently been legislated for Medicare hospital reimbursement. Health planning and peer review strategies to reduce the development of excess capacity and encourage appropriate utilization may have been responsible for decreases in length of stay in hospitals but have not been sufficient to control overall expenditures. Some attempts to rationalize coverage policy based on technology assessments have not been effective, in part due to lack of central direction and data deficiencies for Medicare intermediaries (48).

A 1980 study found that cost-sharing decreases utilization of physician and hospital services for some patients (21,30), and that lack of supplemental coverage results in cost-shifting for those with chronic conditions (21). The reduction in physician services for Medicare beneficiaries was found to occur primarily in patients without chronic impairments (22 percent) and in the *number* of persons seeking physician services. Persons with chronic conditions (78 percent), who most intensively *need* care, were unaffected (21). In the same study, the number of hospital admissions was lower in the group without supplemental insurance, as shown in table 21. Utilization patterns and costs of services were similar once patients entered the system. Patients with public supplementation were the highest users, possibly due to poorer health status.

The effects of the direct cost of services on utilization and health have not been evaluated in persons over 65. Preliminary results from the Rand Health Insurance study (5) show that in younger populations free care resulted in significantly higher utilization rates, but improved health outcomes were not demonstrable for broadly defined physical and mental health measures. Two improved outcomes were identified—better blood-pressure control and improved corrected vision, suggesting that cost can deter persons from seeking needed care for some chronic conditions and that improved access to care can be beneficial for conditions with established treatment regimens. They also suggest that unlimited access to care can result in overuse of services without resulting in better general health. Future analyses of the data from this study will provide useful information about the use and benefit of health services for the nonelderly population studied. Extrapolation of these results to those over 65 must be

Table 21.—Average Utilization of Health Services by Elderly Medicare Beneficiaries, by Type of Supplementation, 1976

	Annual physician visits		
Type of supplementation	No chronic conditions	Some chronic conditions	Annual hospital days
No supplementation: Medicare only	1.66 (100%)[a]	6.72 (100%)	2.51 (100%)
Private supplementation	2.30 (139%)	6.23 (93%)	2.79 (111%)
Public supplementation: Medicaid	2.71 (163%)	8.92 (133%)	4.41 (176%)

[a] The numbers in parentheses indicate the average utilization rate for a group *relative* to the utilization rate among those beneficiaries who do not supplement their Medicare coverage.

NOTE: Calculations based on tabulations from the 1976 Health Interview Survey.

SOURCE: Link, Long, and Settle, 1980 (21).

done with caution because health problems and utilization of services may be quite different in older persons.

Advocates of increased beneficiary cost-sharing and pro-competition approaches suggest that current reimbursement systems—government and private insurance programs that insulate the consumer from the true cost of service—promote the use of excessive health services and promote higher fees by providers (24,43,45). Use of these approaches is aimed at reducing unnecessary services and making patients more prudent shoppers for medical care. Prudent buying by health consumers remains a largely uninvestigated proposition and presumes the ability of the patient to distinguish between unnecessary and essential services (48). Some researchers have suggested that health care is not "an ordinary article of commerce" (35), suggesting that it should be treated differently in the marketplace for technical and ethical reasons. Others have suggested that there are inherent problems in enabling patients to be prudent shoppers at the point of purchase (6) because:

- consumers are poorly informed,
- consumers cannot accurately assess the care they get,
- consumers confront the system in times of crisis, and
- consumers sacrifice other things to pay for health care.

Periodic multiple-choice schemes in which selection of benefits is tied to the purchase of insurance removes the purchase decision from a crisis situation. However, appropriate selection of health insurance benefits requires a great deal of information. Also, because insurers are faced with the problem of adverse selection (those who are most frail purchase more coverage), the risk may not be spread over both high and low users.

Channeling patients to lower cost providers through preferred-provider organizations or contracting may be effective in reducing the costs of care. The restriction of freedom of choice, however, places increased responsibility on the government and insurers to ascertain that incentives to reduce visits or ancillary services do not adversely affect the quality of care.

In evaluating policy options, the total care impact of alternative strategies for meeting the projected increase in demand for health and long-term care services should be explored. In addition to operating and administrative costs for services, such other factors as capital costs and program startup costs should be considered.

Federal and State efforts to contain costs of institutional care

CONTAINING HOSPITAL COSTS

Current cost-containment activities have focused on reduction of the costs of institutional care—hospital and nursing home services. Prospective payment for hospital services is being phased in for Medicare, cost-control mechanisms have been enacted for a number of State Medicaid programs, and some States have instituted cost controls on all payers. It is hoped that because of the importance of Medicare revenues to hospitals, prospective payment for Medicare alone will reduce costs overall,[4] rather than cause a shift of cost to other individuals or other payers. Prospective payment systems become more effective in influencing the way hospitals deliver service when all sources of payment are covered. But cost-shifting will not be tolerated indefinitely by non-Medicare payers.

The Medicare prospective payment system calculates costs on a per-case basis using DRGs to adjust for differences in the type and severity of cases. The case-mix adjustment reduces incentives for avoiding more difficult and costly cases. Still, prospective payment may encourage an increase in the number of admissions, particularly in the number of those with lower care requirements. Older patients are more likely to require more intensive services and longer periods for recovery. Current DRG categories may not adequately account for differences in severity of illness. The incentive to reduce the level of services for a patient argues for careful monitoring of the quality of care.

The scope of services covered is not comprehensive—at least during the phase-in period. Capital costs, teaching costs, and outpatient costs are not covered, providing an incentive for hospitals to shift costs to these categories. There are also incentives for shortening lengths of stay, but these may increase the use of outpatient services not covered under the system.

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[4] For a complete discussion, see (48) and (49).

Prospective payment should reduce the use of ancillary services and encourage the adoption of cost-saving technology. The impact of prospective payment on medical technology will be stronger if capital costs are ultimately included, but even here the impact must be considered on a case-by-case basis (48).

States are also actively involved in trying to control the cost of hospital care. A publication by the Senate Special Committee on Aging provides an overview of these activities (53). Revenue caps, rate and budget review, DRGs, price competition, capitation approaches, and channeling patients to specific providers are some of the mechanisms being tried. States with mandatory rate-setting programs did have slower growth of per capita hospital expenditures. New programs are being implemented in response to the Omnibus Reconciliation Act of 1981. The results of these efforts on costs, quality of care, use of technology, and health care providers, if they are documented, can provide useful information to guide Federal policy.

CONTAINING LONG-TERM CARE COSTS

Most approaches to slowing the growth of long-term care costs have attempted to limit access to nursing homes or substitute lower cost community-based services for more expensive nursing home care.

The number of nursing home beds available can affect utilization and cost. Licensed nursing home beds, estimated to number about 1.4 million in 1980, are operating at very high-occupancy rates —90 percent and more. Control of the number of nursing home beds has been used to limit Medicaid nursing home expenses by some States (44).[5] Growth in numbers of beds is limited by the certificate-of-need policies in the States. For example, between 1976 and 1980, the number of beds increased by 3 percent per year (44). For the 1978-81 period, aggregate nursing home days and the population over 75 also increased by 3 percent per year. Shortages in nursing home beds in some regions impede access for some beneficiaries and may increase the days spent in hospital waiting for nursing home placement.

The feasibility of providing long-term care in noninstitutional settings has been clearly demonstrated for certain subgroups of the elderly. Evaluation of the cost and effectiveness of these programs has been difficult because of design problems. In general, savings in total system costs have not been demonstrated. Most agree that services delivered are valuable, but targeting strategies have not focused on those who are both functionally disabled and socially isolated—those who are most likely to become institutionalized (55). The National Channeling Demonstration Programs are focused more directly on targeting, cost containment, and case management, to test whether a managed system of long-term care can produce more favorable results than the current system (7). The research and evaluation design for these studies has also been strengthened with the goal of producing definitive results (32).

SECTION 2176 WAIVERS

Section 2176 of the Omnibus Reconciliation Act of 1981 amended the Social Security Act to permit States to more freely experiment with home and community-based care. The requirements that aggregate spending not increase and that these services directly substitute for nursing home care make it illegal to use home and community services as an add-on. The problems with targeting services to those at risk for nursing home care have been discussed above. Difficulties in predicting what expenditures might have been without the waivers will make evaluation of cost savings from these programs difficult. Lack of adequate measures of patient outcomes or comparison groups also will inhibit cost-effectiveness evaluation (55). Programs such as these do, however, create incentives for new efficiencies in providing community-based services that are considered more desirable than nursing home care for many reasons that are not cost related.

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[5] See GAO report for discussion of State Medicaid Policies for Funding Nursing Home Care (44).

Capitation approaches

Since 1972, health maintenance organizations (HMOs) have been able to enter either reasonable-cost or risk-based contracts for both inpatient and outpatient services for Medicare beneficiaries. The Health Care Financing Administration has established several capitation demonstration projects for acute care services. Preliminary data indicate that better management of care and financial incentives have controlled costs and improved effectiveness (17,32). Cost savings were achieved by offsetting the increased use of ambulatory and home care services by reduced use of hospitals (12,32). HMOs that owned and operated ambulatory clinics, home health agencies, hospitals, and nursing homes show the most marked shift away from institutional services (32,54).

A new model combining acute and long-term care services is the social/health maintenance organization (S/HMO). The linking of acute and long-term care provides an opportunity to capture cost savings over the whole continuum of care and encourages the least intensive level of care (32). This model is currently being developed and evaluated through the Florence Heller School at Brandeis University. Fears about the budgetary effects of waivers necessary to implement this program delayed its implementation.

CONTAINING PHYSICIAN COSTS

Reducing the costs of Federal payments for physician services requires reducing utilization, paying lower fees, increasing beneficiary cost-sharing, or some combination of these. Setting lower fee schedules for Medicare or constraining fee increases beyond the current requirement[6] could reduce the number of physicians who accept assignment. Assignment means that the physician is reimbursed directly for 80 percent of the cost, and the beneficiary pays the 20-percent coinsurance. About 50 percent of physicians currently accept assignment. For nonassigned services, the beneficiary is responsible for the entire cost and can then be reimbursed by Medicare for 80 percent of *allowable* charges (which are usually significantly lower than the *billed* charges). Hence, for nonassigned services, physicians can shift the difference between allowed and billed charges to the consumer.

In addition, more private cost-sharing for existing benefits under Medicare Part B, which covers physician services, has been proposed by the current Administration. Higher premiums to cover a higher percentage of operating costs (48,52) as well as coinsurance rates and deductibles could also augment revenues. Higher premium costs would have less effect on reducing service utilization but would shift costs to beneficiaries and distribute them over the entire Medicare population (48).

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[6] Increases cannot exceed the Medicare Economic Index.

Technology and coordination of Federal health programs

The potential for cost-shifting between the programs and for noncomplementary policies and incentives can affect both the cost of and access to appropriate technologies and services. For example, new computer and information technologies can facilitate coordination and improve the cost effectiveness of Federal health programs. A number of Federal programs influence the ability of those over 65 to purchase services and technology. These include cash and in-kind service benefits that are age-based entitlements and those that serve specific groups, such as the socially and economically disadvantaged, or veterans, including those over 65. From the standpoint of access to health and long-term care services and technologies, Federal and federally assisted programs that influence the quality and distribution of services and technologies as well as private insurance benefits are also important.

Federal health programs

The following major programs are cited to illustrate the complex interaction of Federal programs in affecting access to health services and technologies.

INCOME SUPPORT

Improved socioeconomic status, reflected in higher general standards of living, and better access to health care have been associated with improved health and functional status (23,42). While Medicare provides an important subsidy for health care, the elderly still have substantial out-of-pocket expenses for health services and technology. Income support programs such as Social Security and Supplemental Security Income may, therefore, affect health status and health program costs.

IN-KIND HEALTH BENEFITS

Medicare provides acute hospital and skilled nursing care benefits (Part A) to most persons over 65; supplementary medical insurance (Part B) for physician and outpatient services is an elective option. Medicaid, in 52 federally assisted, State-run programs, supplements this coverage for the poor, and in some States for those who are needy due to increased health care expenses. Medicaid also provides a "safety net" for those who require extended nursing home care.

SOCIAL SERVICE PROGRAMS

Social and supportive services are provided through Social Service Block Grants and Title III of the Older Americans Act. Services vary from State to State but can include homemaker, chore services, transportation information and referral, congregate meals, and home-delivered meals.

VETERANS ADMINISTRATION (VA) PROGRAMS

The VA provides comprehensive benefits to veterans with service-connected disability and to all veterans over 65 on the basis of need and availability of resources (Public Law 91-500). Currently, many veterans choose to use private services and be reimbursed through Medicare. The number of veterans over 65 who are eligible for both VA and Medicare benefits is expected to *triple* (from 3.5 million to 9 million) by 1990. Applications for VA health benefits have increased significantly (the rate of increase in the number of applications per 1,000 veterans was over 30 percent during fiscal year 1983) (16). Some of this increase may be due to recent changes in the Medicare program. More specific examination of the rates for veterans over 65 is needed.

HEALTH SERVICES AND HEALTH RESOURCE PROGRAMS

Health services and resource programs provide Federal support to the medically underserved and aid in manpower development, health planning, and community and preventive health services. Activities under these programs can affect the availability of services and technologies through health planning activities and health care expenditures. These programs interact with State-specific certificate-of-need programs that regulate the supply of certain technologies and services (e.g., institution-based home care, dialysis, therapeutic and diagnostic equipment), and particularly the supply of hospital and nursing home beds.

Actions taken in any of these programs can produce unintended effects in others. Cost-shifting, changes in the number and characteristics of persons seeking services, and impaired access to services and technologies, either financially or geographically, can occur. Lack of adequate data on use and the factors that affect it often hinders efforts to evaluate potential effects of policy changes.

Hospital backup

The problems in delivery of long-term care that result in a patchwork of services have been discussed in chapter 7. The coordination between acute and long-term care adds further complexity, as does the interaction between public and private health and long-term care financing alternatives (discussed later in this chapter). Cost containment may create additional stresses that can result in cost shifting and, without adequate safeguards, affect the quality of care. The problem of the backup of patients in hospitals is an example.

Certain policies have been effective in reducing the length of hospital stays. Utilization review quickly identifies those patients who no longer need hospital care. Because out-placement of these patients can be difficult, the Medicare provision for nursing home care—instituted to contain costs—is underutilized because beds are not available.[7] The result is a large number of hospital days that are not necessary for medical reasons. The cost of these "administratively necessary days" (ANDs) in 1980 ($3.7 billion) was slightly greater than the amount spent on community-based care in that year, as shown in table 22.

The Medicare nursing home benefit is seldom used. Medicare pays for only about 2 percent of nursing home days of the elderly, and an average stay is 28 days compared to the allowed 100 days. Medicaid (40 percent) and private payments (58 percent) are the major sources of nursing home revenues (50). Higher quality standards retrospective denial of claims, and difficult regulations related to accounting for allowable costs make Medicare participation less attractive for the limited benefits. The availability of Medicare nursing home benefits depends on: 1) existence of a skilled-level nursing facility (SNF)—a function in large part of Medicaid policy; 2) Medicare participation by the SNF—a function of the similarity of Medicaid and Medicare rules, certification, types of patients, and reimbursement policies; and 3) interest on the part of nursing homes in participating.

Until the enactment of prospective, case-based payment, delays in nursing home placement were problems for the Federal budget, rather than for providers and patients. Nursing home users were operating at 95-percent occupancy rates and hospitals at 75-percent occupancy rates; because Medicare funding was seldom terminated, patients simply received hospital care at hospital costs after their medical condition was stabilized. New incentives have been created for hospitals to rapidly discharge patients. But no incentives have been created to encourage nursing homes to accept Medicare patients. The availability of beds for these patients is a function of the relative attractiveness of Medicare and the State Medicaid program policies, as well as care requirements for individual patients. The short supply

Table 22.—Formal Long-Term Care Expenditures in Hospital Care, Nursing Home Care, and Community-Based Care, by Source of Funds, 1980

	Hospital patients awaiting nursing home placement	Nursing home	Community based
Federal:			
Medicare	1,568	455	1,042
Federal Medicaid	419	5,694	85
Federal Title XX	—	—	809
AOA	—	—	724
Veterans Administration	1,562	359	723
Other Federal	104	21	135
State and Local:			
State Medicaid	354	4,788	73
State Title XX	—	—	420
Other State	198	—	211
Local government	—	—	17
Private:			
Insurance	902	129	740
Business/philanthropy	29	129	162
Consumers	209	8,869	1,377
Total	5,345	20,444	6,518

SOURCE: U.S. Department of Health and Human Services, Office of the Inspector General, *Long-Term Care: Service Delivery Assessment, Report to the Secretary* (2 vols.) unpublished, N. Zimlich, December 1981. For detailed explanation of estimates see Volume II: Technical Report.

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[7] Nursing homes can selectively admit patients based on care needs and reimbursement status and thus still maintain high bed-occupancy rates.

of nursing home beds makes access highly variable and difficult in most areas (15).

Current provisions of DRGs account for ANDs in that they have been factored into the base rates. No additional reimbursement will be made for patients waiting to be placed in nursing homes. Many of these patients are poor and require a great deal of care. The care requirements make them poor candidates for home care and because they are poor, they probably cannot afford private care. Careful review of appropriateness of out-placement will be required.

Information technology for coordination of health programs

The rapid advance of information technologies offers opportunities for better coordination of programs through more effective data collection and dissemination of information to consumers, providers, administrators, and policymakers. While information is only one element in the coordination process, it is essential in monitoring its impact and formulating policy. Chapter 6 reviewed the uses of innovative information technologies to improve patients' ability to participate in their own care through education and patient-held health information. Educational technologies can also be applied to improve consuming behavior through helping patients choose between service and coverage alternatives.

Artificial intelligence and computer-assisted learning strategies can assist providers in coping with the complex problems of disease and functional disability, and can also be applied to promote efficiency in health care programs and improve strategic planning activities. Technologies such as the "smart card" (a magnetic information storage card) provide new oportunities to capture patient-based data on the utilization of services and their cost. Artificial intelligence can assist in analyzing information for complex resource-allocation decisions. Electronic information-sharing can improve the ability of multiple providers to act in concert to address individual and community needs. State-of-the-art data collection and analytical tools can enhance the effectiveness of utilization review for both quality of care and cost control.

Confidentiality and protection against abuse must be carefully considered as new applications are developed. The design of effective administrative mechanisms that can use information effectively also requires further development before the maximum benefit of these new technologies can be achieved.

Financing alternatives for health and long-term care

Medicare is the major form of health insurance for those over 65, supplemented by private "medigap" insurance. Gaps in Medicare coverage for the elderly exist in preventive services, dental care, and particularly long-term care. Many of the elderly are not poor and tend to want to save for emergencies (27). The need, resources, and desire for protection imply a market for mechanisms that would provide financial protection for these older persons. Protection against catastrophic long-term care expenses has been discussed most often, but some attention to the structure of medigap insurance is underway and deserves increased attention as a means of filling benefit gaps and reducing medical care cost-inflation (28).

Among the mechanisms proposed for accumulating resources for long-term care are a publicly supported national program, private insurance, and subsidized personal savings programs (e.g., tax-deferred savings).

A compulsory national long-term care insurance program would be one way of providing comprehensive universal coverage. This approach avoids the problems of participation by only those who are at greatest risk of needing care (adverse selection). Fear of increasing inflation of health and long-term care costs and concomitantly increasing government expenditures has hindered full consideration of this approach.

The need for a compulsory national insurance program is partly based on the failure of the private insurance market to provide individual coverage (33). Reasons that have been given for lack of interest of private insurers include:

- cost of coverage relative to income of target population;
- lack of understanding by elderly consumers of their risk and insurance needs (many think they are already protected);
- existence of a public "safety-net" for those who are poor or become poor;
- difficulty in predicting the cost of benefits, including lack of reliable data on which to base estimates of utilization and costs;
- difficulty in distinguishing between skilled nursing, intermediate care, and custodial care; and
- regulatory barriers.

The barriers fall into two major categories—technical barriers to the design of an insurance product and barriers to marketing this product. The technical barriers in designing and administering benefits are similar to the problems that face public programs that pay for long-term care. Public programs have not yet been able to contain the growth of expenditures.

The problems of cost containment, price inflation, overutilization of benefits, and the inability to predict length of care and appropriate level of care are major concerns for private insurers. In addition, private insurers provide benefits that are marketable and must attract insurers who represent an appropriate balance between users and nonusers. Most existing insurance policies for long-term care are focused on nursing home care and provide only limited expansion of Medicare benefits. Some have very limited home care benefits and only a few cover levels of care below skilled nursing.

One approach suggests creating a policy with an idemnity benefit (set-dollar reimbursement) of $37 per day for up to 3 years of nursing home care (27) to be marketed to those over 65. The premiums for the policy were calculated to be about $450 to $550 per year. However, insurance industry estimates of premium costs have been substantially higher. Although these premium costs would strain the health care budgets of many when added to current out-of-pocket spending, some older consumers might consider the potential benefits to be worth the extra cost. For this group it may be an attractive alternative to spending down for Medicaid eligibility. Also, premium costs could be reduced substantially if consumers purchased coverage before age 65.

Benefits of additional private coverage for long-term care could accrue to both individuals and government. Such coverage could reduce the burden on Medicaid because a substantial portion of Medicaid beneficiaries were not initially poor; spending down and transferring assets have made them eligible. Tighter Medicaid restrictions on asset transfers may stimulate increased demand for private insurance protection. The existence of a personal-protection alternative could also alleviate some of the ethical and political problems in increasing the stringency of spending down and greater emphasis on tapping of family resources before becoming eligible for Medicaid benefits.

Insurance regulation varies from State to State and can therefore act as a barrier to the sale of long-term care insurance. The variability in State programs makes it difficult for national companies to design and administer long-term care insurance products.

Incentives for personal savings to defray the cost of future care have also been suggested. Tax-deferred savings programs for this purpose could be offered along with current tax-deferred savings programs for retirement income; the number of persons who could afford such an investment might be relatively limited, although many have purchased individual retirement accounts. The budgetary impact for such a program would have to be carefully analyzed.

Three major kinds of medigap insurance policies are currently available: 1) individual policies that pay deductible and coinsurance for Medicare-covered services at Medicare rates; 2) individual policies that pay deductibles and coinsurance based on what the insurance company determines as reasonable charges (usually higher reimbursement); and 3) group insurance[8] policies, usually as a continuation of employee benefit plans after retirement, that provide major medical benefits as well as deductibles and coinsurance. The premium-to-benefit ratios are reasonable in most cases and relatively fair, but may duplicate Medicare coverage or each other and provide little additional protection. Since the benefits are usually determined by Medicare policy, they do not make coverage a great deal more comprehensive. Voluntary savings programs would have to provide tax savings in addition to those provided by current programs. Rewards for prudence such as sheltering other assets from Medicaid spend-down requirements might be included to enhance the attractiveness of such programs.

A major barrier to the development of private financing mechanisms is that elderly consumers do not understand their health care risks and/or their insurance coverage (20,27). Many think they are adequately protected through Medicare and medigap insurance. The strong preference for first-dollar coverage for acute care and the high cost of such coverage may also limit the amount of money available for additional insurance or savings (27). Although the development of alternatives to government financing seems desirable in improving access to care, significant changes in attitudes and incentives of both insurers and consumers will be required for these mechanisms to become viable.

Findings and conclusions

Health care spending has been growing and will continue to grow under present policies, but the growth of the over-65 population—particularly the over-75 segment—will increase demand for acute and long-term care services. The growth of this population group is *not* the main reason for the rapid escalation in health care costs. Increased costs due to inflation (even surpassing general inflation) and intensification of services have been much more significant factors; increasing costs have led to efforts to contain spending that have far-reaching implications for older persons. While most individuals over 65 can maintain functional independence, many require health care for chronic conditions that increase in prevalence with age. Spending for health services represents a major problem for the Federal Government, individuals, and families.

Medicare currently provides an important health care subsidy for those over 65 but is by no means comprehensive—many necessary services that affect their health and functional status, such as dental services, eyeglasses, and hearing aids are not reimbursable. A growing problem is the cost of long-term care for those who are disabled. Eventually, many older persons come to depend on public means-tested programs for long-term care after their personal resources are exhausted. Private financing mechanisms, including medigap insurance and private insurance for long-term care, are not sufficient to provide adequate supplemental protection.

Demand for health care by older persons is influenced by physical and psychosocial factors as well as economic factors. The increased use of services by some of those in this age group may result from an increased burden of illness. The remarkable decrease in mortality in the over-65 age group has not been accompanied by a similar decrease in morbidity. Studies also indicate that older persons tend to underreport symptoms and may be more likely to delay seeking care. They attribute symptoms to "just getting older." Health professionals may reinforce this behavior by not dealing adequately with functional disabilities. Recent experience in Geriatric Assessment Units found an average of three correctable problems per patient; many of these problems could have been identified through a careful health history without sophisticated diagnostic tests.

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[8] Lower group rates are expected from such insurance plans, as exemplified by group health insurance rates for persons under 65, because of lower administrative costs and better risk spreading.

Cost-containment efforts to date have not been effective in controlling overall health spending. Most approaches have focused on hospital care and rate-setting. The response has been increased utilization or shifting of services to ambulatory settings or shifting costs from Federal programs to other insurers and consumers. Increasing direct consumer costs to reduce overutilization has been shown to reduce the number of persons seeking care, but not to change use patterns after a diagnosis has been made. Capitation approaches have been most successful in encouraging the substitution of lower cost services for expensive hospital care. Recent experiments are extending the capitation concept to include supportive social services.

The coordination of services and benefits between Medicare and the State Medicaid programs, as well as among other Federal, State, and local programs that influence health care, remains a problem in access to care for the elderly. Poor coordination may even increase costs because the most appropriate services are not provided. Better coordination can increase utilization and overall costs, but can also improve the quality of care. The incremental costs and benefits of each action must be evaluated.

The hospital backup problem described in this chapter is an example of conflicting program requirements and, in certain geographic areas, lack of skilled-nursing beds leading to increased costs. Shifting financial incentives through prospective payment under Medicare could affect quality of care for patients in hospitals awaiting placement in long-term care institutions. Premature discharge may result in multiple admissions and shifting of costs to home care, thereby increasing overall costs for these patients as they are cycled back and forth between inadequate community settings and the hospital.

Other reports have addressed questions related to changes in eligibility, benefits, and financing mechanisms for the existing Medicare program to cover increasing costs. Recent Congressional Budget Office reports (45,46) explore options to increase revenues or decrease outlays as well as potential schemes to tie deductibles to income.

Research priorities

Health services research has the potential to provide valuable information for improving the cost effectiveness of the delivery of health services. There are significant gaps in knowledge at present. Some efforts are constrained by technical problems; others are limited by the resources that have been allocated for this purpose. Many of the questions have not been adequately studied in any age group. In other areas, persons over 65 have been excluded from the study population (e.g., The Rand Health Insurance Study). Results from the community-care demonstration activities and the 2176 waiver programs may provide useful information for directing Federal policy.

Additional information is needed in the following areas to direct Federal policy on containing health care costs and improving health care and supportive services for older persons:

- factors affecting the use of health and social services by older persons,
- the effect of cost-sharing on the use of services by and the health status of older persons,
- evaluation of economic incentives on provider-prescribing behavior,
- effectiveness and cost effectiveness of alternative strategies for the care of chronic disease and functional impairments,
- evaluation of alternative strategies for coordinating services and benefits,
- cost effectiveness of alternative quality-assurance mechanisms,
- development of methods to effectively educate older consumers in the prudent use of health services,
- development of improved health-outcome measures for older persons,
- exploration of methods to apply capitation-payment approaches to multi-provider systems,
- development of better assessment tools to identify health and social service needs, and
- refinement of case-mix measures based on severity of illness for patients with multiple diagnoses.

Congressional issues and options

ISSUE 1: Should Congress strengthen quality assurance mechanisms for health care services because of the potentially adverse effects of cost containment?

Options:

1.1 *Congress could strengthen the requirements for review of quality care.*

1.2 *Congress could establish a monitoring system to identify adverse patient outcomes that may be attributable to reductions in level of care and mandate the Prospective Payment Commission to evaluate the implications.*

1.3 *Congress could require refinement of the DRGs according to age group (as a proxy measure for severity of illness) or other surrogate measures for severity of illness or the presence of multiple diagnoses.*

1.4 *Congress could mandate making information on care and its consequences more accessible to patients, including requiring a patient ombudsman in hospitals.*

1.5 *Congress could require that HCFA have applications for Professional Review Organizations reviewed by outside experts to assure adequate plans for monitoring quality of care.*

While incentives to reduce the number and types of services may be effective in encouraging more prudent and economical plans of care, these incentives may also lead to skimping for heavy-care patients. Older patients are more likely to require more intensive services and longer periods for recovery. Current reimbursement policy recognizes this in two ways: 1) it provides higher rates of rembursement for patients over 70, and 2) provides for quality of care reviews through Professional Review Organizations (PROs). However, because analyses were performed on the total hospital population, significant differences between age groupings may have been obscured. Since both the payment system and quality assurance mechanisms are not yet fully implemented, their effectiveness cannot be evaluated. But the proposed regulations and administrative structures should be evaluated for adequate quality-assurance safeguards. The data that will be necessary to guide future policy decisions must also be considered.

Options 1.1 and 1.3 imply action before the current system is implemented. The age break of 70 years was identified empirically. Option 1.2 would provide a system to identify problems if they occur. Option 1.4 would enhance the patient's ability to avoid situations that could place him in jeopardy. Option 1.5 would provide additional assurance that quality of care as well as cost of care considerations are adequately represented in PRO functions. All of the proposed options would increase the cost of quality-assurance programs, but savings could also accrue from the prevention of complications.

ISSUE 2: Should Congress act to increase coordination of Federal health and social service programs and to increase liaison with State-run programs to avoid unintended interprogram cost shifting?

Options:

2.1 *Congress could establish additional Federal-level coordinating mechanisms.*

2.2 *Congress could consolidate Federal agency and/or program responsibilities.*

2.3 *Congress could delegate responsibility for coordination of Federal programs to States and localities.*

2.4 *Congress could establish a client-based information system so that total per capita spending can be monitored on a representative sample of beneficiaries.*

2.5 *Congress could encourage the dissemination of information to individuals and strengthen coordination through enhanced consumer decision-making.*

2.6 *Congress could provide increased support for existing coordination efforts through the Administration on Aging, the Area Agencies on Aging, and State-run health programs.*

Current efforts aimed at coordination have not eliminated conflicting program requirements and regulations. The financial impacts of lack of coordination are largely unknown, but cost shifting between Federal programs and between Federal and State programs is known to occur. Enhanced coordination could occur at the Federal level (options 2.1 and 2.2), at the State and local level (option 2.3), or at the individual patient level (option 2.5). Better information on the use and costs of services provided by all health and social services (option 2.4) could lead to better planning, but would introduce higher costs of data collection and could raise problems related to confidentiality of information. Increased activity through existing structures (option 2.6) could be effective but more attention to linkages in certain areas (e.g., housing programs and Veterans Administration programs) seems appropriate. Better coordination could reduce costs through the provision of more appropriate services but could also increase demand for services overall and thereby increase total costs.

ISSUE 3: Should Congress stimulate coverage for preventive services, long-term care, and function-enhancing technologies as a way of substituting lower cost services?

Options:

3.1 Congress could increase benefits for prevention and treatment of chronic disorders in addition to current acute care benefits.

3.2 Congress could increase benefits for prevention and treatment of chronic conditions and limit program liability for acute care services.

3.3 Congress could establish additional optional coverage through social insurance.

3.4 Congress could encourage additional optional coverage by creating incentives for private insurance coverage for these services.

3.5 Congress could provide incentives for personal accumulation of resources for additional benefits (e.g., tax-deferred savings).

The addition of benefits to the Medicare program (option 3.1) or restructuring benefits (option 3.2) could lead to a less functionally dependent older population. Little evidence exists on whether this would lead to cost savings. In the short run, costs would likely increase. The provision of other types of optional coverage (options 3.3 and 3.4) is another approach to providing additional benefits. Technical, marketing, and regulatory barriers have inhibited private insurers' development of appropriate mechanisms to distribute risks. Social insurance schemes would likely require additional Federal resources. Personal accumulation schemes (e.g., tax-deferred savings plans, home-equity conversion) have been proposed by some (option 3.5), but these would be most effective for moderate and upper income persons. Alternative methods for the poor and near-poor would therefore be required if equity of access is to be maintained.

ISSUE 4: Should Congress act to alleviate the number of patients in hospitals waiting for discharge to lower levels of care?

Options:

4.1 Congress could make Medicare and Federal guidelines more consistent to increase the number of beds available for recuperation of Medicare patients.

4.2 Congress could relax legislative restrictions for designation of swing beds (classifying unused hospital beds as skilled-nursing beds) in hospitals.

4.3 Congress could exempt hospitals from certificate-of-need requirements for adding home health services.

4.4 Congress could encourage more active discharge-planning efforts.

4.5 Congress could encourage the building of additional skilled-nursing beds in shortage areas.

Making more Medicare nursing home beds available (options 4.1, 4.2, and 4.5) would increase the use of this benefit, thereby increasing program costs. Some savings from a reduction of hospital payments could occur in those cases where extended lengths of stay produce "outlier payments" (payments in addition to DRG reimbursement for extremely long stays). Also, patients requiring intense community sevices because of lack of informal support might be cared for more economically. Better access to home and community services (options 4.3 and 4.4) could reduce pressure and outlier costs for hospitals but would increase the cost of home care benefits.

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Chapter 9

Technology, Housing, and the Living Environment of the Elderly

Contents

Page
Introduction 277
Demographic Influences 277
  Changes in Households 277
  Marital Status 278
  Living Arrangements 280
Housing Status of the Older Population 282
  Tenure of Elderly Households 282
  Housing Deficiencies 283
  Housing Expenditures 285
  Recent Changes in Expenditures and Deficiencies 286
Housing and Environmental Fit of the Impaired Elderly 288
  Age, Impairment, and the Housing Environment 288
  Impairment and Disability 288
  Prevalence of Disability 290
Evolution of Federal Housing Policy for the Elderly 294
  General Housing Policy and Federal Programs 294
  Federal Housing Programs for Older Americans 294
  Impact of Federal Housing Programs on the Elderly 300
The Macro-Environment of Housing for the Elderly 301
  Characteristics of Elderly Single-Family Housing 301
The Micro-Environment of Housing for the Elderly 315
  Technological Applications in the Home 315
Concluding Remarks 324
Research Priorities 325
Issues and Options 325
Chapter 9 References 327

Tables

Table No. *Page*
23. All Households and Households With an Elderly Head: United States, 1950-82 278
24. Marital Status of the Population Aged 65 and Over, by Age and Sex: United States, 1970 and 1982 279
25. Living Arrangements of the Population Aged 65 and Over, by Age and Sex: United States, 1970 and 1981 280
26. Elderly Headed Households, by Tenure: United States, 1979 and 1982 282
27. Housing Characteristics of Elderly Headed Households: United States, 1979 283
28. Deficiency Criteria for Physically Inadequate Housing: United States, 1981 284
29. Incidence of Housing Deficiencies and Excess Expenditures: United States, 1979 285
30. Persons Needing Help in Basic Activities of Daily Living and Persons in Nursing Homes, by Selected Ages: United States, 1977 291
31. Noninstitutionalized Persons With Activity Limitation Due to Chronic Conditions, and Persons Dependent in Selected Basic Activities of Daily Living (ADLs), by Age: United States, 1977 291
32. Mobility Limitations Due to Chronic Conditions Among Noninstitutionalized Persons, by Age: United States, 1977 292
33. Summary of Housing Units for the Elderly Currently Subsidized by Selected Federal Housing Programs: United States, 1981-82 296

Figure

Figure No. *Page*
27. Schematic Diagram of the Competence and Environmental Press Model: Behavioral Outcomes of Person-Environment Interaction 289

Chapter 9

Technology, Housing, and the Living Environment of the Elderly

Introduction

Major demographic and technological changes in housing and living arrangements of older Americans in the recent past signal new challenges for Federal housing policy in the future.

Understanding the effects of these trends for the elderly is particularly relevant because of the growing importance of the residential environment as persons age. Questions of safety, security, satisfaction with life, and maintenance of independence are only a few of the issues that have a bearing on Federal policy in housing, technological change, and the elderly (see, e.g., 43). Moreover, as the elderly population itself ages, greater challenges arise for assuring that the very old are not only adequately housed but also properly served (74).

Issues surrounding "housing and the elderly" go beyond the physical dwelling itself. The status of older persons in terms of their housing and living arrangements is intricately related to their socioeconomic, marital, familial, psychological, and physical status. Whether directly or indirectly, Federal housing policy affects central aspects of the older individual's well-being.

This chapter discusses the demographic, social, and technological developments that have helped create the current Federal role in housing policies affecting the elderly. It includes a synopsis of the major Federal housing programs that have an impact on the older population, their relative contribution to providing or subsidizing housing for this special group, and their current status or level of activity. It also provides an analysis of potential future needs in Federal housing policy and in achieving the explicit goal of assuring "safe and decent housing" for all persons and families, as first stated in the Housing Act of 1937.

More recent Federal legislation sets out the special nature of the housing needs of the elderly, especially the desirability of coordinating housing with a variety of community services. Increasingly, the emphasis is on maximizing and maintaining the residential independence of older persons, particularly those who are frail, disabled, poor, and/or living alone. Technological innovations in residential settings and development of new service delivery systems, ranging from low to high technologies, are already being applied toward these goals.

Demographic influences

Changes in households

Although it is clear that ever larger numbers and proportions of people are surviving to age 65 and beyond, the *composition* of this population must be considered when assessing the housing needs of the elderly. Among the key factors are age, sex, marital status, and living arrangements.

It is also important to distinguish between *persons* and *households* as demographic variables. The household is the best unit of analysis for discussing housing concerns, since it is the consuming entity and reflects the actual number of dwelling units that are occupied. During the decade of the 1970s, the over-65 population grew by 28 percent, to 25.7 million persons. In contrast, the rate of growth for the total population was only

11 percent; this age-specific growth differential has existed for most of this century. (See ch. 2 for a complete discussion of these trends.) Moreover, during the 1970-80 period the aging of the older population itself was shown by the 33-percent increase in the over-75 population, and the even more marked increase of 61 percent in persons over 85.

This impressive growth in numbers of persons only forms the underlying basis for assessing housing demand by the elderly. The change in numbers of households is more relevant. According to the Annual Housing Survey of the Bureau of the Census, by 1980 there were 16.5 million households maintained by a person over 65. This figure is about one-fifth of all U.S. households, a proportion that has been increasing since World War II. Thus, while the number of older *persons* doubled between 1950 and 1980, the number of *households* headed by older persons increased even more—by a factor of 2.5 (from 6.4 million to 16.5 million). Table 23 shows these trends from 1950 to 1982.

Table 23 also shows the variability of decennial percent changes in both total and elderly households, which reflects the wide variation in fertility rates of earlier decades. The low fertility rates of the 1930s lessened the demographic potential for future household formation. The cohort born between 1930 and 1934 exerted relatively little influence on household formation in 1959 (i.e., when these individuals reached age 25 to 29, a major life-cycle stage for household formation). Similarly, when this cohort reaches age 65 to 69 in 1999, they will add a relatively small number and proportion to the total of elderly households.

Therefore, despite the higher decennial rates of growth in elderly households since 1950, the rate of increase has both varied and slowed. In 1950, fewer than 15 percent of U.S. households were headed by elderly persons; this figure rose to 19.6 percent in 1970 and to almost 21 percent in 1982. The earlier increases in elderly households were largely due to the increased likelihood of older persons maintaining independent households and the general trend toward greater survivorship in old age.

The trend in household growth among the elderly is expected to slow during the rest of this century (66). Issues related to quantity or supply of housing for older persons are likely to be less crucial than questions regarding its financing, maintenance, and distribution. Also, new issues regarding the integration of housing policy with public services, especially long-term care, will become increasingly important.

Marital status

Increased emphasis on quality of the living environment and service coordination is predicated on the differences in types of households within the older population. Age-based differences in marital status and living arrangements of the older population have remained quite stable during the last two decades, but sex-based differences have changed somewhat. Table 24 shows the dis-

Table 23.—All Households and Households with an Elderly Head: United States, 1950-82 (numbers in millions)[a]

	All households		Households with elderly head[b]		
Year	Total number	Percent change preceding decade	Number	Percent change preceding decade	Percent of total
1950	43.4	—%	6.4	—%	14.7%
1960	52.6	21.2	9.4	46.9	17.9
1970	62.9	19.6	12.3	30.9	19.6
1980	80.7	28.3	16.5	34.1	20.4
1982	83.5	—	17.3	—	20.7

[a] Figures are for the noninstitutionalized population.

[b] Elderly head of household is a person aged 65 or older.

SOURCE: Data derived from U.S. Bureau of the Census, *Current Population Reports*, Series P-20, Nos. 381 and 366, and Series P-25, No. 805; *Current Housing Reports*, Annual Housing Survey, 1980.

Table 24.—Marital Status of the Population Aged 65 and Over, by Age and Sex: United States, 1970 and 1982 (percent distribution)

Year and marital status	Male Age 65+	Male Age 65-74	Male Age 75+	Female Age 65+	Female Age 65-74	Female Age 75+
1970: [a]						
Never married	7.5%	8.0%	6.6%	7.7%	7.8%	7.5%
Married, spouse present	69.9	75.2	60.4	33.9	43.5	19.1
Married, spouse absent	3.2	2.8	3.9	1.7	1.6	1.9
Widowed	17.1	11.3	27.7	54.4	44.0	70.3
Divorced	1.3	2.7	1.4	2.3	3.0	1.3
Total	100.0	100.0	100.0	100.0	100.0	100.0
1982: [b]						
Never married	4.4	4.9	3.3	5.6	5.3	6.1
Married, spouse present	77.6	81.5	70.2	38.5	49.3	2.4
Married, spouse absent	2.4	2.5	2.3	1.7	2.0	1.2
Widowed	12.4	7.5	21.7	50.4	38.3	68.5
Divorced	3.2	3.6	2.4	3.8	5.1	1.8
Total	100.0	100.0	99.9	100.0	100.0	100.0

[a] 1970 figures are based on total civilian resident population.

[b] 1982 figures are based on total civilian resident population, excluding persons who are institutionalized.

SOURCE: U.S. Bureau of the Census, *Current Population Reports*, Series P-20, Nos. 212 and 380.

tribution of marital status within the older population by age and sex in 1970 and 1982.

Most noticeable are the similarities *within* the sexes and the age groups for both years. Although not shown, data for 1960 had similar relative differences. Those differences in marital status that do exist are found *between* the sexes and age groups within either year. For example, although widowhood is perceived as an increasing problem for older women, the proportion widowed actually declined between 1970 and 1982. For all older women, widowhood was 4 percentage points *lower,* at 50.4 percent in 1982. To the extent that widowhood reduces quality of life in older age (2,48,49), the overall status of older women has improved slightly. By a similar difference of 4.5 percent, the proportion of women over 65 who are married with spouse present has increased to 38.5 percent.

In 1982, 12.4 percent of older men were widowed, a proportion one-fourth that of their female counterparts. Over three-fourths of the men were married with spouse present. Even for men over 75, 70 percent were still in that category, compared with only 22 percent of women in that age group. Thus, while recent trends have been toward increases in proportions married for both sexes and all older age groups, the lifestyle "advantage" for older men has actually improved proportionally.

But increasing *numbers* of older women are becoming widowed, especially when compared to men. Between 1970 and 1982 the number of widowed older women rose by 1.7 million (to 8.1 million), even though the proportion in that category was 4 percentage points lower. In contrast, there has been an actual decline in the number of widowed older men—from 1.42 million in 1970 to 1.34 million by 1980. The proportion of all widowed older men was almost 5 percentage points lower by 1982 (90).

Thus, the numbers of widowed older women, while increasing, are doing so at a decreasing rate. There has been no significant change in numbers of older men widowed during the last 12 years. Because life expectancies at birth, at age 65, and even at age 85 are higher for women, their increase in total numbers has been greater, thereby enhancing both the positive and negative changes that have occurred in their marital status.[1]

The growth in the total number of older men was almost entirely comprised of those who were married with spouse present. Almost 8 percent more older men were in this category in 1982 than in 1970, a gain of 2.2 million. In contrast, the additional 2 million women who were married with spouse present represented only one-half of the total increase in older women from 1970 to 1982. The other 1.9 million were either never married, widowed, divorced, or separated.

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[1] The total population of older males grew by 2.1 million between 1970 and 1982, while the total female older population gained almost twice that amount (3.9 million) during the same period.

Various factors account for these differences. As noted above, age- and sex-specific differences in life expectancy continue to have an impact on the sex composition of the older population, although their respective rates of increase have slowed. Moreover, husbands are, on average, 3 to 4 years older than their wives, thereby increasing the "risk" of female widowhood by increasing the average age differential between spouses. Finally, even among married older persons, who have higher life expectancies in general, wives still have notably higher life expectancies than husbands (66).

Living arrangements

These demographic influences and their social impacts are also seen in the living arrangements of the older population. Data for 1970 and 1981, shown in table 25 (comparable 1982 data are not yet available), indicate the changes in—and the differences between—the living arrangements of older men and women. A notable change since 1970 has been the dwindling proportions of both men and women who live with someone other than a spouse, especially those over 75. The proportion of all older men living with someone else dropped from 14.2 to 9.1 percent. Even more dramatic is the decrease in older women living with someone else, which fell from more than 27 percent in 1970 to less than 20 percent in 1981. The largest decrease was for women over 75: from more than one-third to less than one-fourth. The likelihood that very old women will be living alone has thus increased substantially since 1970.

In 1981, 79 percent of men 65 to 74 were living with a spouse, compared with only 47 percent of women in that age group (who also showed an increase since 1970, but a less dramatic increase than for men). A more profound difference is found for the over-75 population. Almost two-thirds of these men lived with their spouses in 1981, but fewer than one-fifth of all women over 75 did so. The effect of differences in life expectancy between the sexes on the living arrangements of the elderly is, therefore, much greater for the *very old* population.

Among all older women, almost 39 percent lived alone in 1981, 5 percentage points higher than in 1970. The comparable figure for older men was

Table 25.—Living Arrangements of the Population Aged 65 and Over, by Age and Sex: United States, 1970 and 1981 (percent distribution)[a]

Year and living arrangement	Male			Female		
	Age 65+	Age 65-74	Age 75+	Age 65+	Age 65-74	Age 75+
1970:						
In households	95.5%	96.4%	93.7%	95.0%	97.6%	91.1%
Living alone	14.1	11.3	19.1	33.8	31.6	37.0
Spouse present	69..9	75.2	60.4	33.9	43.5	19.1
With someone else	11.5	9.9	14.2	27.4	22.4	35.0
Not in households	4.5	3.6	6.3	5.0	2.4	8.9
Total	100.0	100.0	100.0	100.0	100.0	100.0
1981:						
In households	96.2	97.9	92.9	93.8	97.8	88.3
Living alone	13.8	11.1	19.0	38.8	34.2	45.1
Spouse present	74.1	79.0	64.8	35.5	47.3	19.3
With someone else	8.3	7.8	9.1	19.4	16.2	23.8
Not in households	3.8	2.1	7.1	6.3	2.2	11.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

[a] Figures are for the total civilian resident population.

SOURCE: Siegel, 1983; based on data from U.S. Bureau of the Census, *Current Population Reports*, Series P-20, various nos.

less than 14 percent. More than four times as many women as men over 65 lived alone in 1981 (i.e., more than 6.0 million women v. fewer than 1.5 million men).

Women over 65 also have higher risk of institutionalization than their male counterparts. While the proportion of all older men who are "not in households"[2] declined from 1970 to 1981 to 3.8 percent, the proportion of older women in that group increased to 6.3 percent. As in the case of widowhood, women face a much greater risk of institutionalization at the oldest ages (75 and over) and the difference has been increasing; their rate of institutionalization increased from 8.9 percent in 1970 to 11.7 percent in 1981. This change is correlated with the growth toward a much higher proportion of very old women who live alone (45 percent in 1981 v. 37 percent in 1970).

Elderly women who are likely to be institutionalized are also likely to be very old, widowed, living alone, and poor. Although these factors contribute to the likelihood of functional dependency and institutionalization (99), an encouraging trend is the recent decline or leveling in the proportion of both men and women aged 65 to 74 who are institutionalized. This change can be partly explained by the recent increases in proportions married and living with their spouses.

The most recent trends in both marital status and living arrangements among elderly men and women thus indicate four general changes:

1. There is an increase in the proportions of older men and women who are married and living with their spouses. These trends are equally evident for both young-old and very-old males, as well as for young-old females. For very-old women, no change in proportion who are married with spouse present has occurred during the last decade.
2. Smaller proportions of older men and women, across all age subgroups, are living with someone other than their spouses. This trend is particularly evident among very-old women.
3. Institutionalization rates for the younger subgroup of older persons (the young old) have decreased, especially for elderly men. But among the very old, these rates have increased, notably so for women.
4. The proportion of older men who live alone has remained constant, but the proportion of older women living alone has markedly increased.

Most of these trends are expected to persist in the foreseeable future. Between 1980 and 1995 little change is anticipated in the proportions of elderly men and women who are either single or married and living with a spouse. Nor are the proportions of older men who live alone or with someone other than a spouse expected to change significantly (89).

The one clear change expected over the next 15 years is an increase in the proportion of so-called "nonfamily" households[3] among elderly women, i.e., those who live alone or with nonrelatives. Corresponding to this shift will be a decline in the proportion of households headed by elderly women living with other relatives (from more than 54 percent in 1981 to 50 percent by 1995). In general, over 55 percent of *all* households maintained by elderly persons in 1995 are expected to consist of persons living alone or with nonrelatives, four-fifths of which will be headed by women (89).

The changes are more dramatic for the over-75 population. In 1981, two-thirds of all households headed by a person over 75 were single-person or nonfamily households, which are projected to remain at that level through 1995. Women are expected to comprise almost 84 percent of these single and nonfamily households in the over-75 population.

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[2] The category "not in households" corresponds to "in group quarters," which includes the "institutionalized," of whom 96 percent are in nursing homes and the remainder in other types of group quarters.

[3] Bureau of the Census estimates and projections for "nonfamily" households do not include persons who are institutionalized.

Housing status of the older population

These demographic trends among the elderly indicate the need for new approaches by the Federal Government to the housing needs of the older population. The data reviewed here underscore the dual growth in both family units and single-person elderly households since World War II. This growth in U.S. households maintained by elderly persons was accompanied by increases in the numbers and proportions of older persons in institutions (i.e., nursing homes and personal care homes, including domiciliary and board and care facilities). These institutions and their residents are not included in the count of households, but they currently house approximately 1.4 million elderly residents—more than 2½ times their number in the mid-1960s. The following sections are restricted to the housing situation of the noninstitutionalized elderly.[4]

Tenure of elderly households

Among the 16.5 million "elderly households" in 1980, approximately 12.3 million were owner-occupied and only 4.2 million were renter-occupied. This relatively high rate of homeownership among the elderly has been increasing since World War II. By 1970 over two-thirds of all elderly households were owned; by 1979 the proportion had increased to almost 72 percent (tables 26 and 27). Included in the growth of elderly homeownership is an increase in the prevalence of manufactured or mobile housing units. By 1980 over one-fifth of all elderly homeowners resided in this type of housing (56).

The growth in ownership during the 1970s has continued during the 1980s. By 1982 the number of elderly-headed households reached 17.3 million, of which 76 percent (13.2 million) were owner-occupied and 24 percent (4.1 million) were renter-occupied (90). Thus, not only did the number of elderly-headed households increase by 1.1 million units in just 3 years, but the entire net growth was in owner-occupied households. The same period showed a net decrease in elderly renter-occupied households: from 4.6 million in 1979 to 4.1 million in 1982.

It should be noted that some of this change is due to underestimates from the 1979 Annual Housing Survey (AHS) data. The 1979 AHS sample used baseline data from the 1970 census of population for its estimates of persons and households. Compared with 1979, the survey data estimates for 1982 have been adjusted upward in accord with 1980 census counts for persons and households.[5] If the average 2 percent adjustment from the 1980 census base is applied to the 1979 survey data, more accurate estimates of change can be developed (see table 26).

By adjusting the 1979 survey data as shown in table 26, the 1979-82 increase in total elderly households was 0.8 million units. Using these adjusted figures, the number of elderly owner-occupied households increased by 1.4 million and the number of renter-occupied households decreased by 0.6 million. (Estimates of the inaccuracy of owner/renter distribution in 1979 are not available).

An ever-growing number and proportion of elderly households are owner-occupied. This is one of the most important facts regarding the housing status and problems of older Americans, because housing tenure (i.e., whether owned or rented) of the elderly tends to be associated with

Table 26.—Elderly Headed Households, by Tenure: United States, 1979 (unadjusted and adjusted) and 1982 (numbers in millions)

	1979		
Household tenure	Unadjusted	Adjusted	1982
Total households	16.2	16.5	17.3
Owner-occupied . . .	11.6	11.8	13.2
Renter-occupied . . .	4.6	4.7	4.1

SOURCE: OTA adjustments based on U.S. Bureau of the Census, *Current Population Reports*, Series P-20, Nos. 352 and 381.

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[4] See chs. 2 and 7 for details on the types of older persons most likely to be institutionalized and the types of care provided.

[5] These most recent 1980 census-based adjustments resulted in a 2-percent increase, on average, in the civilian noninstitutional population, as well as in the number of families and households that are used for estimates from census survey data since 1980.

Table 27.—Housing Characteristics of Elderly Headed Households: United States, 1979 (numbers in thousands)

Housing characteristics	Owner-occupied		Renter-occupied	
	Number	Percent	Number	Percent
Total households	11,609	71.6%	4,605	28.4%
Median household income	$ 8,904		$6,500	
Poverty status	1,741	15.0	1,289	28.0
Median value of house/median gross rent	$38,900		$ 168	
Single-person household	4,302	37.1	3,032	65.8
Two-or-more person household	7,307	62.9	1,573	34.2
Unit built before 1940	4,891	42.1	1,950	42.3
Unit lacks some or all plumbing[a]	321	2.8	269	5.8

[a] See table 28 for details.

SOURCE: Adapted from 1980 AHS survey data; Struyk and Turner, 1982 (71).

various social and demographic characteristics related to need for assistance. Furthermore, the development, applicability, and accessibility of new technologies in the dwelling unit may involve different approaches for owned v. rented units.

Those elderly who rent their dwelling units are, in general, more likely to need government assistance to achieve decent, safe, and sanitary housing. Differences exist not only between renters and owners, but also between owners who still have a mortgage indebtedness and owners who do not. Table 27 shows some of the general differences between elderly households that are owner- v. renter-occupied.

These 1979 data illustrate the general differences in housing status that persist today among the older population. Almost 72 percent of all elderly headed households in 1979 were owner-occupied;[6] of these, 63 percent contained two or more persons and 37 percent contained only one person. In contrast, elderly renter-occupied units comprised less than 30 percent of the total, and fully two-thirds of these were occupied by only one person. Renter-occupied households were almost twice as likely as owner-occupied households to have incomes below the poverty level.

Housing deficiencies

Housing adequacy can be similarly differentiated. There is a high association among such characteristics as living alone, poverty status, and various other factors related to housing adequacy. As noted earlier, elderly persons who live alone are more likely to be women, very old, poor, and inadequately housed; they are also more likely to have inadequate diets, need social supports and services, and be in ill health than are those who live with one or more other persons.

Compounding the difficulties for those who live alone, especially renters, are problems related to the housing units themselves. The data in table 27 show that renters not only have lower median household incomes, they are also twice as likely to be living in a unit that lacks some or all plumbing (although there are a greater *number* of owner-occupied units with inadequate or missing plumbing). Elderly rental units are also more than twice as likely to have two or more dwelling deficiencies than are elderly owned units (103).

Analysis of AHS data shows that among all elderly renters in poverty in 1979, almost one-third were in units with one or more physical deficiencies. Table 28 shows eight major physical deficiency categories that are used by the Department of Housing and Urban Development (HUD) for the AHS. These criteria emphasize the severity of the housing deficiencies that are included in the data cited above. Following the example of other analyses, table 28 lists two groups of deficiencies, "structural" and "maintenance" (71).

Because of the requirements for the two categories under "maintenance deficiencies" (e.g., at least three of four common area problems), it is reasonable to assume that their prevalence is understated in available housing survey data. Many units with some structural deficiencies, including local municipal building code violations and safety hazards, might not be included in the more stringently defined AHS data.

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[6] The estimates in table 26 imply that the proportion of owner-occupied units in 1982 had increased to 76 percent, but this figure may be slightly high.

Table 28.—Deficiency Criteria for Physically Inadequate Housing: United States, 1981

Type of deficiency	Description of deficiency
Maintenance deficiencies:	
Physical structure	Has at least three of five structural problems: • leaking roof; • open cracks/holes in interior walls or ceilings; • holes in floors; • peeling paint or broken plaster over 1 square foot of an interior wall; • evidence of mice/rats in the last 90 days.
Common areas	For a multi-unit building has at least three of four: • no working light fixtures in common hallway; • loose, broken, or missing stairs; • broken or missing stair rails; • no elevator in buildings of four or more stories.
Structural deficiencies:	
Plumbing	Lacks or must share some or all plumbing facilities: • hot and cold piped water; • flush toilet; • bathtub or shower. Lacks adequate provision for sewage disposal: • connection with public sewer; • septic tank; • cesspool; • chemical toilet.
Kitchen	Lacks or must share some or all kitchen facilities: • sink with piped water; • a range or cookstove; • a mechanical refrigerator.
Electrical	Lacks electricity. Has at least three electrical deficiencies: • one or more rooms without a working wall outlet; • fuses blown or circuit breakers tripped three or more times in the last 90 days; • exposed interior wiring.
Heating	Has unvented gas- or oil-burning room heaters.

SOURCE: Adapted from Struyk and Turner, 1982 (71); based on HUD AHS criteria.

In 1979, 11.5 percent of all elderly households that received no Federal housing assistance (i.e., not federally regulated) had at least one physical deficiency. Among renter-occupied elderly households the comparable figure was 17.2 percent; among owner-occupied households without a mortgage, the prevalence was 10.1 percent and only 6.5 percent for owners with mortgages. Note that about 80 percent of all elderly homeowners do not have mortgages. Thus, generalized data on older homeowners are biased toward the characteristics of those without mortgage indebtedness, thereby providing inadequate information about elderly homeowners with mortgages.

Some of the highest incidences of housing deficiencies are found among the elderly in poverty, regardless of tenure status; almost one-third of poor elderly owners and renters occupy dwellings with at least one deficiency. Housing problems are especially acute for the most vulnerable and isolated elderly. Forty percent of unassisted elderly households in rural farm areas and small towns occupied physically deficient dwelling units in 1979. In contrast, 22 percent of elderly households in urban areas of nonmetropolitan counties and only 12 percent of those in metropolitan counties were in that category.[7]

Moreover, within each of the three tenure groups (renters, owners without a mortgage, and owners with a mortgage), black households (all ages) had the highest incidence of dwelling disrepair. Forty-six percent of all black renter-occupied households were physically deficient in 1979, compared with only 13 percent for all other renter households. The same comparisons exist for mortgaged owner-households (25 percent for black households v. only 4 percent for white) and nonmortgaged owners (36 v. 8 percent, respectively).

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[7] A metropolitan county is generally defined as any county with at least one central city of 50,000 or more population, as well as any contiguous county that is economically and socially integrated with the metropolitan county that contains the central city.

Housing deficiencies are thus not only higher among elderly than nonelderly households, they are particularly severe among Americans who are also poor, black, and/or renters. These differences have remained constant since the early 1970s, despite the overall improvement in the housing quality for the elderly vis-a-vis the nonelderly population (71).

Housing expenditures

Relative housing expenditures of the elderly are also higher. A generally accepted index of excess housing expense, adopted by HUD, uses the following criteria:

> Excessive housing expense burden occurs when:
>
> - for renters, gross rent (contract rent, plus utilities paid by the tenant) reaches more than 30 percent of gross household income;
> - for owner-occupants, direct expenditures for housing (excluding those for major maintenance and improvements) reach more than 40 percent of gross household income.

Among unassisted households in 1979, excess expenditures were incurred by over 18 percent of elderly households and 15 percent of nonelderly households. However, notable differences exist in the distribution of the expenditure burden *within* the two age groups (table 29). Among nonelderly households, 33 percent of the renters and 8 percent of the owners with mortgages had excess housing expenditures. For elderly households, the corresponding figures were dramatically higher: 55 percent for renters and 25 percent for owners with mortgages. The overall rates by age group are closer, because fewer than 20 percent of all elderly homeowners have a mortgage, compared with more than 60 percent of the nonelderly. Thus, in terms of both absolute and relative figures, those renters in both age groups who do not receive any housing assistance are far more likely to be burdened with excessive housing costs.

Table 29.—Incidence of Housing Deficiencies and Excess Expenditures: United States, 1979 (percent distribution)

Age group and tenure status	Physical deficiencies	Excess expenditures
Nonelderly households:		
Total	7.6%	15.2%
Renters	13.2	33.4
Owners with mortgage	3.1	7.9
Owners without mortgage	7.9	1.7
In poverty	26.3	70.8
Renters	28.7	86.5
Owners with mortgage	17.1	73.2
Owners without mortgage	26.2	18.2
Elderly households:		
Total	11.5	18.4
Renters	17.2	55.3
Owners with mortgage	6.5	25.3
Owners without mortgage	10.1	4.5
In poverty	29.0	41.0
Renters	31.0	74.9
Owners with mortgage	33.6	74.9
Owners without mortgage	27.4	17.7
Owners with mortgage:		
Black	24.7	44.3
Other	3.8	22.6
Owners without mortgage:		
Black	36.5	7.2
Other	8.3	4.4
Renters:		
Black	46.0	57.8
Other	13.3	55.0

SOURCE: Adapted from Struyk and Turner, 1982 (71); data are only for households not receiving housing assistance.

Other differences in housing expenditures exist. Poverty status, combined with lack of housing assistance, is clearly a major reason for excess housing expenditures for both the elderly and the nonelderly. Among all impoverished nonelderly households, 71 percent experienced excess housing costs in 1979, especially the renters (87 percent). Over 73 percent of poor, nonelderly owners with mortgages also had excessive costs (compared with only 18 percent for their nonmortgaged counterparts). The largest differences among the nonelderly exist in the rates for the poor compared with the total population, regardless of household tenure. Only 8 percent of all owners with mortgages and a mere 2 percent of those without mortgages had excess expenditures. But one-third of all nonelderly renter-occupied households were in this predicament.

Although elderly renters and mortgaged households, on average, have notably higher rates of excess expenditures than nonelderly households, these differences are either reversed or nonexistent when specifically comparing *only* the poverty level households of the two age groups. Among all impoverished renters, the elderly households were less likely to have excess expenditures than the nonelderly, in part because of smaller dwelling requirements and available Federal subsidies. The expenditure rates for owner-occupied households in poverty were virtually the same between the two age groups (70).

Poverty-level households of all ages, occupied by renters or owners with mortgages, have by far the highest levels of housing expense burden. Thus, among those who do *not* receive housing assistance, the cost of housing weighs most heavily on those with the least resources. Black households, young and old, are the most vulnerable, especially black renters, who had both the highest rates of physical deficiencies (46 percent) and of excess housing expenditures (58 percent).

Thus, for households not receiving housing assistance, the risks of housing inadequacies and excessive costs are distributed differently among subgroups of the population:

- Among all households, renters are most likely to face physical deficiencies in their units.
- Among all renters, those who are black, poor, and/or elderly are more likely to live in physically inadequate housing.
- In contrast to the nonelderly, impoverished elderly owners with mortgages are most likely to be in housing with physical inadequacies, followed by impoverished elderly renter-occupied households.
- Except for owners without mortgages, the poor of all age groups are highly likely to have excess housing expenditures. Over one-half of renter-occupied elderly households were burdened by excess housing costs.

Recent changes in expenditures and deficiencies

While higher proportions of older Americans have consistently had excess housing expenditures, the *relative* change in this burden during the late 1970s was generally lower for the elderly than for the nonelderly (71). From 1974 to 1979, the incidence of excess housing expenditures increased by 38 percent among all nonelderly and 29 percent among all elderly households. The notable exception was for elderly owners with mortgages. Although comprising only one-fifth of all elderly homeowners, those with mortgages had an increase in housing expense burden of 61 percent (for nonelderly mortgagees the increase was 52 percent). Elderly renters had a notably lower increase of 26 percent in the incidence of excess housing expenditures.

The greatest increase in cost burden was for owners without mortgages: 67 percent for the elderly and 89 percent for the nonelderly. Low-income elderly and nonelderly households had distinctly lower net cost increases from 1974 to 1979, except for owners without mortgages. These data indicate that owners without mortgages, in all age groups and regardless of poverty status, experienced the greatest increases in excess housing costs during the late 1970s.

An additional problem occurred for elderly owners with mortgages: a notable increase of 14 percent in households occupying units that were physically deficient (3 percent for the nonelderly). Indeed, for the elderly and nonelderly groups, the only increases in incidence of deficiencies were for owner-occupied households with mortgages. Renters and mortgage-free owner households of all ages had *decreases* of up to 31 percent in physical housing deficiencies.

Clearly, the trend is toward better quality housing for most households, except for poverty-level elderly owner-occupants with mortgages. The 1974-79 increase in the incidence of physical deficiencies in their units was an extremely high 72 percent. These households of older persons are least likely to either undertake or afford regular maintenance or major repairs. As a result, these dwellings—already likely to be among the oldest housing stock—suffer the consequences of this neglect.

Among elderly households themselves, some further differences exist in housing quality and excess expenditures. Available data from the AHS indicate that owner-occupied households maintained by persons over 70 have higher incidences of physical deficiencies as well as excess expenditures than households headed by those 65 to 69. These differences exist for both mortgaged as well as mortgage-free elderly households. For example, 10 percent of mortgaged owners over 70 v. 4 percent of those 65 to 69 were in physically deficient housing in 1979. For those without mortgages, the proportions were 11 and 9 percent, respectively. Similar age-based differences were found with respect to excess expenditures, particularly among owners with mortgages. Excess costs were experienced by 28 percent of heads of household over 70 and by 23 percent of those 65 to 69 (71).

Among elderly renters, 50 percent of households headed by persons 65 to 69 and 58 percent of households headed by those over 70 had excess housing expenditures. The one exception to these differences is for physical deficiencies, where 19 percent of households headed by younger elderly and 16 percent of those headed by persons over 70 were in physically deficient units.

These survey data suggest some additional generalizations about trends and changes in the housing status of older Americans. Among households not receiving housing assistance, the following major trends occurred from 1974 to 1979:

- Overall, housing quality improved for most elderly as well as nonelderly households, especially poor renters and owners without mortgages.
- Elderly households without mortgages had the highest increase in the incidence of excess housing costs.
- These two trends imply that improvements in the quality of housing among the elderly have been "bought," in part, at the cost of greater expenditures for both renters and mortgage-free households.
- Among all tenure groups, only elderly owners with mortgages had a net increase in the incidence of physical deficiencies, compounded by a high increase in excess expenditures.
- Among elderly owners, the older the head of the household the greater the degree of both housing deficiencies and excess expenditures.

Thus, elderly households as a whole are less well housed and burdened by greater excess expense than nonelderly households. But such a generalization ignores even more important differences that are relevant to Federal housing policies, especially those concerned with targeting resources where they are most necessary.

One implication is that careful targeting of public policy for housing assistance could go beyond the current emphasis on low-income renters, both elderly and nonelderly. Notably vulnerable are those older homeowners who have both mortgage indebtedness and household incomes below the poverty level. They number up to 280,000 households, one-third of which are in physically deficient units. Moreover, most of these deficient dwelling units were built before 1940, and many need major structural repairs and greatly improved maintenance.

Even though the monthly mortgage amount may be small relative to the average for newer mortgages, it is sufficiently burdensome to this group of poverty-level householders to place them among the three-fourths with excess expenditures. Thus, the clear dilemma for this subgroup of the older population is their high probability of living in deficient and possibly dangerous housing, while being the least likely to afford improvements to the dwelling unit.

Housing and environmental fit of the impaired elderly

Another aspect of the housing situation of elders concerns not only the quality and cost of housing, but its viability as a supportive environment for older persons who have limitations in functional abilities or suffer from chronic impairments.

Congress and the Federal Government have exhibited growing concern since the early 1960s for functionally limited or disabled persons.[8] However, such concern has primarily been for rehabilitation programs directed toward those who are considered employable (e.g., largely through vocational education and training programs).[9] Far less concern has been shown for developing support for older disabled persons who are not likely to be in the paid labor force.

Only in the last decade, after considerable pressure from advocacy groups, has Federal legislation been created to broaden the scope of assistance and protection for disabled persons of all ages. An example is the 1978 amendments to the Rehabilitation Act, one section of which emphasized and affirmed the civil rights of all disabled Americans. Two other examples are the 1976 amendments to the Architectural Barriers Act and amendments to the Housing and Community Development Act, both of which attempted to assure equal access to federally owned, operated, and subsidized commercial or residential buildings.

But most programs for the disabled remain targeted toward employment opportunities, income maintenance, and health care (83). Few are specifically oriented toward promoting independent living; those that are have only recently been developed and implemented in a haphazard and slow manner. Notwithstanding such limitations, these recent efforts attempt to promote the maximum independence of disabled and elderly persons by providing financial assistance and incentives for self-care and services in the least restrictive environment.

Age, impairment, and the housing environment

The evolution of Federal programs benefiting the disabled and elderly occurred in part because of the growing recognition that physiological aging is often accompanied by decrements in functional abilities (32). Recent legislative objectives pay more attention to the problems of functional impairment among the elderly. But definitive information on the functional problems of the elderly in their housing environment is limited. Descriptive, but sometimes inconclusive or contradictory, research on aging and the environment has been developed on issues such as the neighborhood (25,59), types and quality of housing (44), and institutional living (34,96). Federal housing and aging programs respond only in part to these issues, even though they have become increasingly relevant to older people. As the older population itself continues to age, the challenge grows for assisting older persons to maintain independence in their housing units and the community.

Their demographic and household characteristics can either enhance the ability of older persons to live independently in their own homes or exacerbate problems they encounter in daily activities. For instance, informal supports from family or other household members often substitute for public agencies or technological applications in the home to assist older persons who are frail or unable to independently carry on activities of daily living.

Impairment and disability

The impact of functional limitations is best understood by distinguishing among the concepts of "impairment," "disability," and "handicap" (83). *Impairments* are physical or mental abnormalities that can be identified or diagnosed. (Chs. 3, 4, and 7 discuss impairments that are particularly evident in the elderly.) An impairment, such as chronic hypertension or severe arthritis, may become a disability if it interferes with the person's ability to perform one or more functions. In this sense, *disability* relates most closely to functional limitation and can be specified in terms of a person's problems in performing regular activities of daily living. These activities can range from personal care (basic) tasks, such as bathing and dressing, to instrumental tasks, such as working, shopping, or driving an automobile.[10] One or more disabilities are considered a *handicap* only in terms of the social and environmental context of the disabled individual. When a disability cannot be overcome by technological intervention (e.g., anti-hypertensive drugs or prosthetic devices), formal or informal supports (e.g., family assistance or home chore services), or other types of assistance, it becomes a handicap (100).

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[8] See ch. 7 for a more detailed discussion of functional limitation or disability, chronic conditions, and other factors related to physical and mental impairments among the elderly.

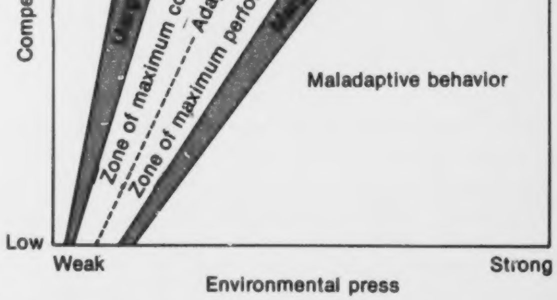
[9] Major legislative initiatives in this regard were the Education of the Handicapped Act and its Amendments, the Rehabilitation Act of 1973 (and especially, its 1978 Amendments), and the Vocational Education Act of 1963.

But determining when such a handicap is present is often difficult. The same disability can be a handicap in one environment but not in another, as well as for one individual but not for another in the same environment. This dilemma is one reason that accurate measurement of functional limitations must include many domains, including social resources, personal feelings of wellbeing or control, and environmental fit (36). For example, a person disabled by severe arthritis may be handicapped in a two-story house but not in a single-level one. In addition, the values and attitudes of disabled persons concerning their impaired status and the nature of their living environments will affect their feelings of constraint or degree of handicap.

This approach has been well developed in studies on the psychosocial aspects of institutions for older people, particularly nursing homes. Kahana (34) developed a model of "person-environment congruence" to explain how behavior varies in response to the physical, social, and psychological milieu of the institutional residential environment. Others have developed similar person-environment interaction models that can be more generally applied to other residential situations. In the latter, the range of possible behaviors and responses of the individual is greater, because control and adaptation are more probable. The optimal environment is one that "fits" or is congruent with the needs of the individual.

For older persons with some degree of functional impairment, environmental congruence becomes more difficult to achieve. This problem has been conceptualized as "competence and environmental press" (45). "Competence" represents the individual's functional capacities in terms of health, perception, cognition, and motor skills. "Environmental press" is a type of environmental stress or demand placed on the individual that activates behavior. The relationship between the individual's competence and the environment's press creates a broad spectrum of adaptive behaviors. The more competent the individual, the greater the ability to respond positively to environmental press. A schematic diagram of this interaction is shown in figure 27.

Figure 27.—Schematic Diagram of the Competence and Environmental Press Model: Behavioral Outcomes of Person-Environment Interaction



SOURCE: Adapted from Lawton and Nahemow, 1973 (45).

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[10] Ch. 7 discusses such activities as "basic physical activities" or "home management activities." These terms are used interchangeably with those in this chapter, such as "activities of daily living" (ADL) or "instrumental activities of daily living" (IADL).

But it is difficult to determine when environmental press is strong enough to induce functional dependence in the older person (i.e., when he or she moves from the marginal to the maladaptive behavior situation in fig. 27).

Although these interrelations are situation-specific, they suggest broader applications for the older population as a whole. In general, chronically disabled persons are likely to become increasingly dependent as they age; this is a function of lowered physiological reserve and increased prevalence of multiple disabilities (100). This likelihood, combined with the knowledge that the social supports and physical environment of the elderly can be altered, indicates the need for increased efforts to implement home-based supportive strategies.

Prevalence of disability

Assessing or measuring the extent of functional disability among the noninstitutionalized elderly is imprecise, in part because of the nebulous and contextual distinction between disability and handicap. Two important benchmarks of the difference between the institutionalized and noninstitutionalized elderly are their relative rates and degrees of functional disability *and* dependence on others for supportive care (99). As noted in chapter 7, institutionalized elders are highly likely to suffer from at least one mental or physical impairment. An estimated 50 to 60 percent of elderly persons in nursing homes have some degree of organic mental disorder, primarily dementia of the Alzheimer type. Almost 9 out of 10 institutionalized older persons have at least one chronic impairment. From the perspective discussed above, they are disabled persons with inadequate environmental supports in the general community (high environmental press), which necessitates some type of institutional care.

The characteristics of institutionalized older persons contrast with those of community-dwelling individuals in terms of person-environment congruence. Although the data are by no means satisfactory, differences in impairment levels between these two groups of elderly persons can be discerned. Two of the most common survey measures of disability are the "activities of daily living" (ADL) and the "activity limitation" scales. The ADL measure appears in a number of functional assessment instruments used in community studies, clinical evaluations, and needs assessment surveys for aging program development. The ADL scale measures whether the individual needs help in performing six basic activities: eating, dressing, transferring (to/from bed or chair), bathing, toileting, and maintaining continence. The original ADL scale (37) is often used in conjunction with the measures of "instrumental ADL" that indicate need for assistance in preparing meals, doing housework, going shopping, or handling money.

Risk of nursing home admission is most highly associated with dependency in a number of ADL tasks. An analysis of merged data from the 1977 National Nursing Home Survey (NNHS) and the 1977 National Health Interview Survey (NHIS) indicated that major predictors of nursing home residency included: 1) dependency in many ADLs (especially the basic ones of eating, toileting, bathing and/or dressing); 2) a diagnosed mental disorder; 3) poverty; and 4) lack of a spouse/widowhood.[11] These conclusions can be compared with the findings of other studies that functional impairments increase dramatically with age, especially among persons over age 85. (For detailed data, see ch. 7.)

When this information is combined with other data from surveys of older persons who are living in nursing homes, different characteristics emerge in terms of the degree, extent, and types of functional impairments that exist among the young old, old old, and very old subgroups in the older population. Table 30 summarizes one aspect of these differences.

This information adds another perspective to the demands that functional impairments make on elderly persons in the community. The residential environment and the types of support that can be provided to mitigate these impairments take on increasing importance as a person's age

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[11] These merged data allowed comparison between a nationally representative sample of the community-dwelling elderly population and a sample of nursing home patients comprised largely of those who were "residents" for more than 3 months (i.e., long-stayers). Most "admissions" to nursing homes are short-stayers whose chronic impairments are different (47,99).

Table 30.—Persons Needing Help in Basic Activities of Daily Living and Persons in Nursing Homes, by Selected Ages: United States, 1977 (percent distribution)

Age group	(A) Percent with basic ADL dependency[a]	(B) Percent in nursing homes	Ratio of "B" to "A"
65-74	3.5%	1.4%	.40
75-84	11.3	6.4	.56
85+	35.1	2.6	.61

[a] These figures include *all* persons who reside in either the community or in nursing homes and who are dependent in one or more basic ADL tasks.

SOURCE: Health Care Financing Administration, January 1981 (91).

approaches 85. One inference from these data is that, all things being equal, the risk of institutionalization is not as great for those elderly who are impaired in instrumental ADL (e.g., shopping or housework) as compared with basic ADL tasks. It is for impairments in instrumental ADL that families, community resources, social services, and various technologies are most likely to provide assistance.

This conclusion is corroborated by studies of "burnout" by family caregivers of functionally impaired elderly. A "crisis threshold" appears to exist, at which point the stress on family caregivers becomes too great and institutionalization of the disabled parent or spouse is highly likely (102). When incontinence or the inability to feed oneself becomes severe, or other basic physical or mental abilities are greatly diminished, the supports (informal, formal, or technological) may be insufficient to permit continued residence in the home.

Other measures of functional disability also show greater prevalence among the elderly. Degree of "limitation in activity," generally disaggregated by "major" and "nonmajor" activities, is a commonly used measure. There are limitations to the inferences that can be made from these data, because of questions concerning how older retired persons may interpret the word "major" (paid work is the most common referent for "major activity"). Although the incidence of major limitations among the retired elderly may be underreported, the NHIS data indicate a consistent relationship between increasing age and the prevalence of activity limitations and ADL dependency (table 31).

In 1981, 47 percent of all noninstitutionalized persons over age 65 had some kind of limitation in their daily routine. Of these persons with limitations, 86 percent were limited in a major activity, i.e., paid work or housekeeping (93). Thus, 4 of every 10 elderly people have some degree of major restriction in their environment, and this ratio increases dramatically for the very old (63 percent; table 31). The chronic conditions primarily responsible for these activity limitations are arthritis/rheumatism, heart conditions, visual impairments, and hypertension; these are followed in prevalence by diabetes and hip or leg impairments.

The ability to cope with such restrictions often depends on one or more of the following: 1) the availability of persons who can provide assistance, 2) technologies and devices that assist the individual to perform tasks, and 3) environmental design that reduces the impacts of these restrictions. According to 1979 data, the need by older persons for assistance in "any one" of seven basic ADLs (i.e., an unduplicated count) increases dramatically with age. For all older persons in the community, 9 percent need some type of assistance to perform any one of the basic activities. Within the older population the proportion grows dramatically from 5 percent of those 65 to 74 to

Table 31.—Noninstitutionalized Persons With Activity Limitation Due to Chronic Conditions, and Persons Dependent in Selected Basic Activities of Daily Living (ADLs), by Age: United States, 1977 (percent)

	All ages	45-64	65-74	75-84	85+
With activity limitation	13.5%	23.0%	38.6%	48.4%	63.2%
Dependent in at least one ADL[a]	0.7	0.7	2.2	5.8	15.0
Dependent in four ADLs..................	0.1	0.1	0.4	0.6	3.7

[a] The activities of daily living (ADL) in these data include bathing, dressing, eating, and toileting.

SOURCE: Health Care Financing Administration, January 1981 (91).

35 percent for persons over 85[12] (94). Slightly higher proportions are found for persons needing assistance in instrumental, or home management, activities (10.5 percent of all older persons in the community, ranging from 6 percent of the 65 to 74 group to 40 percent of those over 85).

Therefore, based on an estimated elderly *noninstitutionalized* population of 26 million persons in 1983 and the NCHS 1979 survey data noted above, more than 2.3 million older Americans living in the community need assistance in performing a basic ADL such as bathing, dressing, or walking. More than 2.7 million need assistance with instrumental activities such as shopping, household chores, etc. Although the data do not account for the relationship between the two groups of tasks, most persons needing assistance with basic activities are probably included in the number requiring home management help. As discussed later in this chapter, such assistance can be from persons who provide informal supports, formal services, technologies in the home and community, or some combination of these.

The restrictions faced by most older persons do not, in general, confine them to their homes. Problems with mobility and the need for assistance increase both by age and by distance from the home. In 1977, just over 8 percent of all older persons in the community needed help in getting around outside their neighborhood. Within their neighborhoods, 6 percent required mobility assistance and less than 3 percent needed help getting around within the dwelling unit. Table 32 indicates the positive relationship of distance from home and increasing age with need for mobility assistance among the elderly.

Table 32.—Mobility Limitations Due to Chronic Conditions Among Noninstitutionalized Persons, by Age: United States, 1977 (percent)

Mobility limitation	65+	65-74	75-84	85+
Outside the neighborhood. .	8.4	4.6	12.0	30.6
Within the neighborhood . . .	6.0	3.1	8.3	24.4
Within the house.	2.6	1.4	3.5	10.8

SOURCE: NCHS, unpublished data, 1983.

Two other mobility limitations should be considered regarding older persons living at home. Although table 32 shows that their prevalence increases outside the home, mobility restrictions in using stairs around or within the home are especially problematical for the elderly. They are a major contributor to falls among the elderly, who are highly vulnerable to them; the elderly account for more than two-thirds of all deaths from falls in the United States. Special tabulations from the 1978 AHS indicate that almost 10 percent of those older persons sampled had specific mobility limitations in "going up or down stairs," compared with only 4 percent who had problems "getting around inside the dwelling" (54). The same AHS tabulations showed that 3 percent of the elderly were limited in their ability to "use equipment in the dwelling" (e.g., kitchen, bathroom, etc.). Overall, 13 percent of the AHS respondent sample had at least one limitation in "personal mobility" (54).

These data from various sources lead to the following generalizations about the functional abilities of older noninstitutionalized persons and the implications regarding their living environments:

- Available indices of functional impairment indicate that dependence in *basic* ADLs (especially eating and toileting) is much greater for institutionalized older persons, as is mental confusion. Such dependency increases greatly for persons over 85.
- Risk of institutionalization is related to person-environment congruence; the older the person is, the more likely that this congruence will not exist for the community-dwelling elderly (in independent households). This risk is exacerbated for those who are poor and who live alone.
- Dependence in *instrumental* ADLs, such as shopping and housekeeping, is more likely to be mitigated by different types of support, such as those from family and friends, formal services, and assistive devices.
- Past survey data suggest that among the 26 million older persons living in the community in 1983:
  —2.3 million needed some type of assistance in performing one or more basic ADLs (personal care);

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[12] These figures increase for rates based on assistance needed in "one or more" ADLs (i.e., a duplicated count): 7 per 100 age 65 to 74, 16 per 100 age 75 to 84, and 44 per 100 age 85 and over. These rates cannot be translated into unduplicated population figures.

  - 2.7 million needed some type of assistance in performing instrumental (home management) activities;
  - persons dependent in basic ADLs are highly likely to also be dependent in instrumental ADLs, but not necessarily vice-versa;
  - 10.5 million had some type of limitation in a major activity, and an additional 1.7 million were limited in a minor activity;
  - mobility limitations are less prevalent than other types of functional impairments, except for using stairs (affects 2.6 million) and traveling outside one's neighborhood (affects 2.1 million); and
  - approximately 780,000 had a notable limitation in using household appliances and equipment.
- Except for the measure of general activity limitation, the prevalence of functional impairments (basic and instrumental ADLs, mobility, etc.) is highly correlated with increasing age. In general, prevalence of such impairments:
  - doubles from age 65-74 to 75-84; and
  - triples from age 75-84 to 85 and over.
- These rates of major functional impairment by age are 1½ to 2 times higher for black older men and women.

The various problems with everyday tasks that the elderly face can have a profound influence on their sense of worth and well-being, and their ability to maintain an independent lifestyle. The prevalence data presented above are based on measures that include only those older persons who *need* assistance, *experience* limitations in certain activities, and *have* problems with mobility. It is not possible, given existing data and resources, to estimate the additional number of older persons who may have marginal levels of functional impairment or who do not readily admit such problems, incapacities, or needs.

The aforementioned prevalence data are likely to reflect the minimum degree of functional impairment among older persons who are not institutionalized. The importance of promoting housing environments that ameliorate these problems is, therefore, that much greater. But these supportive environments require very different levels of commitment and assistance from both formal and informal sources, as well as physical characteristics that can promote person-environment congruence.

As noted earlier in this chapter, most informal supports for noninstitutionalized elders come from available family members, especially spouses and daughters (31,64). It is also clear that such support is far more readily available for instrumental tasks than for personal care requirements, since the former can often be provided by friends and neighbors as well as family members (1,85). Most of the research consistently finds that approximately four-fifths of all supportive care is provided by these informal caregivers and the remainder by formal service agencies (64; also, see ch. 7).

Some research also indicates that a hierarchy exists in the composition of the informal support network. When available, spouses are the primary and usually the sole providers of assistance, followed by a daughter or other close family member. Friends and neighbors tend to be primary caregivers only when family support is unavailable, and if the recipient is a long-time neighborhood resident (69). Finally, for the great majority of community-dwelling elderly who do not have major functional impairments in personal care activities, little or no help is provided. When help is needed, it is most likely to be for light housework, heavy chores, and shopping (4).

It remains unclear to what extent the application of technology to the physical housing environment and technological applications within the house mitigate the need for supportive assistance. As the remainder of this chapter indicates, the existing type, design, and nature of housing occupied by most older persons does not provide the kind of supportive environment that many older persons need in order to carry on daily activities with a minimum of dependence on caregivers. In general, Federal housing policies and programs have not been developed to encourage, much less provide, such supportive environments for older persons.

Evolution of Federal housing policy for the elderly

The role of the Federal Government in assisting older Americans with their housing requirements has its roots in the evolution of Federal involvement in housing policy for all age groups. As in many other areas of public concern and government assistance, housing policies specifically for the elderly are a relatively recent development in the history of U.S. housing assistance programs.

General housing policy and Federal programs

The involvement of the Federal Government in housing ranges from direct provision of dwelling units for specified populations to indirect incentives and benefits provided through the Internal Revenue Code (e.g., Federal income tax deduction for mortgage interest paid by homeowners and tax incentives for housing developers). This chapter briefly reviews only the most relevant components of Federal housing policies and programs involving the elderly.

The Federal Government first became involved in housing during World War I, when 5,000 units were constructed primarily to provide housing for defense workers. The project was costly and inefficient, and ended with the Armistice. During the post-Depression period, Federal involvement in housing was resurrected. As part of the National Industrial Recovery Act, the Federal Government subsidized the construction of low-rent housing to assist the unemployed, the poor, and the housing industry itself (24).

The genesis of public housing was the Housing Act of 1937 that, as noted at the beginning of this chapter, established the general goal of Federal involvement to assist local units of government in providing "safe and decent" housing for low-income families. The Federal Government was no longer involved in direct management and construction of public housing units. Moreover, the Act of 1937 primarily served the "submerged middle class" (12) by providing temporary housing during the economic recovery. During the period following World War II, public housing increasingly became the domain of the long-term poor, as the new middle class benefited from FHA mortgage insurance programs and the GI Bill.

The changed nature of Federal public housing goals was reflected in the National Housing Act of 1949, which developed the first major statement for a national housing policy oriented toward urban renewal, slum clearance, assistance to the poor, and subsidies to the housing construction industry. Indeed, the construction of public housing was designed to be efficient, high-density, standardized, and adequate for an average family with children. No distinctions were made for other possible groups of tenants or types of units. Not until the mid-1950s was Federal legislation for assisted housing specifically targeted toward the elderly.

Federal housing programs for older Americans

During the 1950s, Federal legislation began to reflect attention to the growth of the older population and some of the special problems faced by older Americans. One arena for this awareness was public housing. The Housing Act of 1956 was the first to make explicit reference to the elderly as a special subgroup. The Act included four relevant provisions that:

- expanded the definition of "family" to include single persons over 65 in the eligibility criteria;
- allowed local public housing authorities to favor elderly persons ("families") in tenant selection;
- allowed certain private institutions to assist with mortgage payments for persons over 60 who had low-incomes;[13] and
- eased FHA mortgage insurance qualification criteria for those over 60, recognizing them as a special group.

This expansion of public housing legislation for older persons coincided with growing national awareness of and response to the elderly as a special group in need. Passage of the Medicare program in 1965, after more than a decade of effort, was one example of such attention to older Americans (30,50). During this period, however, the elderly themselves were not a homogeneous political force with a strong group consciousness (3). Yet they were often generally characterized as the "deserving poor" and, in a sense, used as a moral force for enacting social programs that might not otherwise have been politically feasible if proposed for the population as a whole.

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[13] This provision of the 1956 Housing Act was the first step toward future legislation that encouraged private sponsorship arrangements for development of low- and moderate-income housing for the elderly.

Housing legislation for the elderly may have been especially favorable in this regard, since public housing projects for the nonelderly were often viewed as undesirable or threatening to the neighborhoods adjoining them. During the 1960s, HUD attempted to institutionalize the decentralization of public housing by applying funding pressure on suburban governments to accept low-income projects. Similar to the introduction of Medicare as a political compromise for a universal national health insurance program (30), public housing exclusively for the elderly "appears to have been a convenient compromise for many [congressional] committees" (52).

Local public housing authorities were far more likely to propose and win community approval for projects oriented toward the elderly, especially in neighborhoods that required changes in zoning ordinances. Cost considerations for both public housing authorities and private sponsors also made elderly housing projects attractive because they were exempt from the density and net area coverage limits of nonelderly housing. For many communities, low- and moderate-income housing for the elderly was an acceptable and even welcome alternative to other types of public housing (42).

The following synopsis indicates the extent of Federal involvement in housing programs that benefit the elderly. Because communities have generally favored HUD-subsidized housing for the elderly over other types of public housing, most new construction of subsidized housing in the last decade has been for projects intended solely for elderly occupants. But the two HUD programs specifically for the elderly (Section 202 and Section 231) have, overall, provided a relatively small number of dwelling units. Table 33 summarizes the various housing programs and their impact on older persons. There are no Farmers Home Administration (FmHA) assistance programs solely targeted for older persons, except for one part of the Section 504 program (as described below).

It is important to note that Federal housing legislation has a very complex history. Most of the programs have been revised, changed, canceled, resurrected, or altered from their original legislation by congressional, regulatory, or executive action. The brief review presented here only highlights their characteristics.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT PROGRAMS

Low-Rent Public Housing.—As noted earlier, public housing began with the Housing Act of 1937, and is the oldest housing program of the Federal Government. It has provided the greatest number of units for the elderly, who currently occupy about 45 percent of all low-rent public housing units. Local housing authorities, assisted by HUD funding, create and manage this housing for families and older persons who meet local income eligibility standards. Tenants' rents cannot exceed 30 percent of their adjusted incomes[14] (33).

This program is still active, but has recently experienced difficulty in finding acceptable sites for new units and in subsidizing the operating costs of existing units (44,81). It provided over 500,000 low-rent units for the elderly in 1982.

Section 8 Rental Subsidies.—Another major form of Federal housing subsidy is the Section 8 program created by the Housing and Community Development Act of 1974. It guarantees payment of a per-unit subsidy to owners of rental property occupied by qualified tenants (i.e., those with incomes below 80 percent of the median in the metropolitan area). The subsidy pays the difference between 30 percent of the tenant's income and the HUD-established "fair market rent." The

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[14] "Adjusted income" is based on a variety of factors such as size and type of household, age of the head-of-household, number of dependents, cash benefits, and other factors.

Table 33.—Summary of Housing Units for the Elderly Currently Subsidized by Selected Federal Housing Programs: United States, 1981-82

	Estimated number		
	Of occupied units	Of units occupied by the elderly	Elderly units as percent of total
HUD programs: [a]			
Public housing	1,121,972	500,885	44.6%
Section 8	1,211,211	630,111[b]	52.0
Section 202	58,773	58,773	100.0
Section 236	386,754	71,800	19.0
Section 231	44,088	44,088	100.0
Section 221(d)(3):			
Rent supplement	81,252	6,195	8.0
BMIR	113,960	259	0.2
Section 232	147,336[c]	147,336	100.0
Total	3,165,346	1,459,447	46.1
FmHA programs: [d]			
Section 502	1,119,091	26,363	2.4
Section 504:			
Loans	51,296	NA	NA
Grants	39,269	39,269	100.0
Section 515	116,102	39,475	34.0
Total	1,325,758	NA	NA

[a] Figures for HUD programs represent units currently insured as of June 1982, whether the program is active or inactive. These are not cumulative figures over the history of each HUD program.

[b] Figures do not include Section 202 households receiving Section 8 subsidies.

[c] The "units" for this program are nursing home beds.

[d] Figures for FmHA programs are cumulative as of September 1981.

SOURCE: Adapted from Congressional Research Service, 1982 (79); and Cohen 1983 (16).

owner-developer may be either a profit-making or nonprofit sponsor. Where Section 8 subsidies are provided for elderly housing, the units are generally developed through the Section 202 program. These rental units may be newly constructed, existing, or substantially rehabilitated.

The Section 8 rental subsidy program remains active, with more than 50 percent of the beneficiaries (over 630,000) being elderly households. Currently, there are problems with cost inflation of rental subsidies for new construction units (versus those for existing units) and undesirable long-term commitments of Federal subsidy funding. These problems are being considered in proposed legislative amendments.

Section 202 (and Section 236) Elderly Rental Housing: Mortgage and Rent Subsidies.—The Section 202 program was first authorized by the Housing Act of 1959, phased out in 1969, and renewed by the Housing and Community Development Act of 1974. The original program provided 50-year direct Federal loans at 3 percent interest to nonprofit sponsors of multi-unit housing built specifically for low- and moderate-income elderly (age 62 and over) and handicapped persons. Over 45,000 units were developed before the program was temporarily replaced by Section 236 under the Housing Act of 1968.

The latter program (Section 236) required mortgages at market rates, with no occupancy restrictions as to type of household. Federal interest reimbursement to the developer reduced the real interest rate; the amount of the subsidy was based on the number of low-income tenants served. Section 8 replaced Section 236 in 1974, although a few new starts have occurred since then from commitments made prior to that time. Because Section 236 only subsidizes mortgages, rapidly increasing operating costs and relatively small increases in rental income have troubled these projects. Currently, about 72,000 units under Section 236 assistance (19 percent of the total) are occupied by elderly households.

The reauthorization of Section 202 in 1974 changed the financing period to 40 years, with interest rates that approximate the market rate.

Subsequent amendments limit the interest rate to 9.25 percent for nonprofit sponsors of these projects. The 1974 reauthorization was important because it:

- promoted greater heterogeneity of tenants by encouraging a mix of low- and moderate-income households;
- encouraged a more equitable distribution by increasing the number of units constructed in nonmetropolitan areas or away from central city core neighborhoods;
- coordinated with the Section 8 rental subsidies to promote affordable housing for low-income elderly households;
- called attention to the special design features that are important in units for the elderly; and
- broadened the definition of "family," specifically for the elderly, to include two or more older persons living together (who need not be related) or one older person plus an "essential person" who provides assistance.

These changes and new emphases made the combined Section 202/Section 8 program more attractive to State and local public housing authorities, as well as to nonprofit sponsors (44). One remaining shortcoming in the program is the continued under-representation of small communities in nonmetropolitan areas in development of Section 202 or other HUD-subsidized housing. FmHA housing programs have not filled this void, in part because the sponsor qualification criteria of both HUD and FmHA[15] limit the likelihood that small town and rural nonprofit entities can be eligible sponsors for such projects (29).

In mid-1982 the Section 202 program was providing almost 59,000 units for the elderly and handicapped.[16] Recently, the program has become more responsive in providing the supportive environments needed by many older persons, including cooperative demonstration programs that incorporate congregate social services into the housing. However, recent legislative proposals (e.g., the Housing and Urban-Rural Recovery Act of 1983) have been designed to phase out Section 202 over the next few years, with restructuring of financing and other program changes anticipated for 1985. Nonprofit sponsorship, flexibility in unit-cost limitations to account for design features that accommodate the elderly and handicapped, and increased attention to shared housing are features of these legislative changes (81).

Section 231 Rental Housing Mortgage Insurance.—The Housing Act of 1959 also authorized the Section 231 mortgage insurance program. Federal insurance was provided for market-rate loans obtained by either nonprofit or profit-making sponsors of rental housing (new construction or substantial rehabilitation) for people in middle- and higher-income ranges; at least 50 percent had to be occupied by the elderly or handicapped. These units tended to be "upscale" in design and quality. Special services and facilities for the elderly were encouraged.

A number of these projects were developed as "retirement centers" or "life care communities" that provided many supportive services, including medical and nursing care when necessary. These projects usually required large "entrance fees" for those advantages, reinforcing the selective bias toward the more wealthy. The entrance fee charge was prohibited in 1963 as a sign of Federal commitment to those most in need of assistance. The program has suffered a very high failure rate through default or foreclosures. Although still "active," Section 231 is not emphasized as an important component of Federal housing policy. In mid-1982 there were over 44,000 units occupied by the elderly; 9 out of 10 are in urban areas.

Section 221(d)(3) Below Market Interest Rate Subsidies and Rent Supplements.—The Section 221(d)(3) program was created by the Housing Act of 1954 and was the precursor of the Section 236 program. It has had minimal impact in providing housing assistance to the elderly. The program initially provided mortgage insurance for multi-family rental housing for low- and moderate-income tenants, but in 1961 it added interest rate subsidies for developers. The subsidies created a "Below Market Interest Rate" (BMIR) by paying the difference between 3 percent and the market interest rate financing obtained by the housing sponsor. No income limits were used to restrict occupancy, but not until 1964 did the program permit elderly persons living alone to be eligible tenants. Also, rent supplements were made available to low-income households.

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[15] The criteria tend to favor projects with 50 or more units, supportive services, secure financing, and prior experience with such housing development—all of which are less likely for nonmetropolitan area sponsors.

[16] These figures are for "currently" insured or subsidized units. They are not "cumulative" numbers since the program was initiated.

The program has been phased out since enactment of Section 236 and, subsequently, the Section 8 rental subsidy program. Currently, a few hundred elderly units are assisted under the BMIR program, and 6,000 units receiving rent supplements are occupied by the elderly (8 percent of the total).

Section 232 Nursing Home Mortgage Insurance.—The Section 232 program subsidizes the construction of nursing home and intermediate care facilities by providing mortgage insurance for their construction or renovation. Facilities must be built for at least 20 patients who require skilled nursing or intermediate care. Eligible sponsors are profit-making or nonprofit corportions that meet all State licensing and regulatory requirements for nursing home development. By 1981 the Section 232 program had provided mortgage insurance for more than 1,300 facilities that contained over 147,000 beds for elderly patients.

FARMERS HOME ADMINISTRATION PROGRAMS

In contrast to most HUD programs, which tend to favor metropolitan areas and medium-sized cities, programs of the FmHA are limited to communities of no more than 20,000 persons that are located within nonmetropolitan counties and communities of less than 10,000 persons within metropolitan counties.

Section 502 Rural Low-Interest Homeownership Loans.—The Section 502 program provides direct low-interest Federal loans to low- and moderate-income families for the construction, purchase or rehabilitation of housing. The housing must conform to FmHA standards, and the loan recipients must be unable to obtain financing at affordable rates in their area. For very low-income households, an "interest credit" subsidy can be obtained that reduces the interest on the loan to as low as 1 percent, but the recipient must clearly be able to afford the property's mortgage, taxes, maintenance, and other payments to be eligible for this special subsidy.

Since its inception in 1965, the Section 502 program has provided over 1.3 million loans. It currently assists over 1.1 million households, only 2.4 percent of which are elderly. Given the higher prevalence of physical deficiencies in elderly occupied housing in rural areas (29), it is unclear why greater numbers have not been recipients of the rehabilitation loans. One suggested explanation is that the incomes of most rural elderly households are too low to qualify for these loans, even the lowest cost ones with the interest credit advantage.

Section 504 Rural Home Repair Loans.—This program was developed to help very low-income households who cannot qualify under Section 502. Section 504 provides home repair loans at 1 percent interest and a payback period of up to 20 years. The maximum loan amount is $5,000 and must be used for repairs that improve the safety and sanitation of the dwelling. Allowable repairs include those for the foundation, roof, heating, water, and septic systems. Another common use of the loans is to repair or add kitchen or toilet facilities.

Direct grants for similar repair needs can be specifically provided to persons aged 62 and over whose incomes are so low that they cannot repay the costs of the repairs. Although the FmHA does not maintain age-specific data across its programs, Section 504 grants for elderly rural homeowners (80 percent of all rural elderly own their own homes) totaling $24 million were obligated in 1981 (81). Also, it has been estimated that 60 percent of the FmHA home repair loans are made to elderly rural homeowners (78).

Section 515 Rural Rental Housing Loans.—Although originally legislated to serve the elderly exclusively, since 1966 the Section 515 program has included families of all ages. It provides direct loans for the construction, purchase, or extensive rehabilitation of multi-unit rural rental housing for low- or moderate-income families, including the elderly and the handicapped. Sponsors can include individuals, public agencies, profit-making corporations, and nonprofit organizations. Interest rates vary depending on type of sponsor and proportion of units devoted to low-income tenants (nonprofit sponsors can receive loans at rates as low as 1 percent). Moreover, a certain number of units in the project can qualify for rental assistance supplements from either the HUD Section 8 program or a similar one through the FmHA.

The FmHA estimates that approximately 34 percent of all Section 515 assisted units are occupied by elderly households (16); about one-half of those units receive rental supplement assistance.

OTHER HUD HOUSING ASSISTANCE PROGRAMS

Section 312 Housing Rehabilitation Loans.—Authorized by the Housing Act of 1964, the Section 312 program provides direct Federal loans to property owners for housing rehabilitation that will bring the dwelling into compliance with area building codes. Thus, the rehabilitation work is often extensive in nature (in 1977 the average loan was over $7,500). The loans carry a 3 percent interest rate and a maximum payback period of 20 years. Applicants must be unable to obtain private financing on comparable terms in their local area. Priority is given to applicants with low or moderate income. However, the program is available only to homeowners in areas where other Federal programs such as urban renewal or Community Development Block Grants (CDBG) are under way. Because of these requirements, the program tends to be available only in certain areas of larger cities. Delays in the approval process, contractor payments, and other administrative problems have plagued the program (44).

Another problem, similar to that with the Section 502 program, is the bias against low-income elderly applicants who may be considered high risks for paying back the loan. This concern for a client's ability to repay the loan has grown because the program's most recent reauthorizations by Congress require that all new loans be funded from repayments and recoveries from existing loans. Precise data on the proportion of older persons receiving these loans are not available. Selected studies indicate that consistently less than one-sixth of all loans are given to the elderly, a figure that is notably below their proportion of all homeowners. A sampling of program reports in 1975-76 showed that less than 20 percent of the loans were made to either the elderly or the handicapped (70). In 1977, about 16 percent of the loans went to homeowners aged 65 and over (44). Figures for more recent years suggest even lower proportions of loans went to elderly households. In 1980 and 1981, about 16 percent of the loans were made to homeowners aged 62 and over (86).

Community Development Block Grants (CDBG).—The CDBG program provides considerable resources to communities for various development efforts aimed at improving housing and neighborhoods in urban areas. Authorized by the Housing and Community Development Act of 1974, the program awards HUD block grants through State allocation procedures to the governments of selected major cities and urban counties. Two-thirds of CDBG funds are targeted for these "entitlement" cities in metropolitan counties; less than one-third of the funds are earmarked for cities with less than 50,000 population. As with other HUD programs, exact data are unavailable on the proportion of CDBG funds that benefit the elderly. Some project funds have helped to build or renovate senior centers (less than 1 percent of all CDBG funds in 1981), and considerably more funding has been used to create centers for the handicapped, to renovate public housing, remove architectural barriers, and undertake other activities that indirectly benefit older persons (86).

Housing rehabilitation efforts comprise a major portion of CDBG funding; 38 percent of the total in 1981. One study of project reports indicated that up to one-third of all rehabilitation grants were made to elderly households (70). Along with other possible sources of assistance for housing rehabilitation, such as Section 312 and Section 502, the CDBG program can provide considerable resources for older homeowners who meet program eligibility criteria. Questions remain, however, about the accessibility of these rehabilitation programs to older homeowners who are marginally poor or who are in communities that may not be targeted under CDBG entitlements or FmHA criteria.

Impact of Federal housing programs on the elderly

The evolution of Federal housing legislation since the Housing Act of 1937 indicates the public commitment to provide adequate housing for those least able to afford it. The concept of Federal housing assistance has expanded, from the first programs that directly provided public housing to the current broad array of programs that provide indirect assistance to different population subgroups in many types of housing. The programs reviewed above exemplify this variety of assistance and indicate the efforts that have been made to recognize and serve the special housing needs of older Americans.

The following generalizations can be made concerning the approach and responsiveness of these programs to helping older persons meet their housing needs:

- Most Federal housing programs subsidize the construction or substantial rehabilitation of multi-unit *rental* housing for income-eligible families through interest rate subsidies, rental cost reimbursement, and mortgage insurance for housing sponsors (not for housing consumers).
- Efforts to respond to the housing needs of older Americans have involved both construction and rehabilitation approaches, but their impact has been disappointing in comparison to the demand for such assistance. For example, the Section 202 and public housing programs have never met suggested annual production goals (e.g., the 1971 White House Conference on Aging set a target of 120,000 new units of elderly housing per year). Annual production has never come close to that rate, as seen in table 33.
- Relative to the long history of Federal housing policy, only recently has greater attention been given to preserving the housing stock through rehabilitation loan programs for owners of single-family housing as well as multi-unit dwellings.
- Federal housing program changes during the 1960s promoted the inclusion of elderly persons, both single and married. Yet restrictive eligibility criteria continued to disproportionately exclude certain subgroups of the elderly, particularly those who were unrelated but sharing a dwelling unit and those who were located outside of central city and metropolitan areas.
- Until recently, Federal housing programs paid little attention to special design and service needs of older persons. In some instances, the design of federally subsidized housing, particularly high-rise public housing, *increased* the likelihood that older persons would become isolated, injure themselves, or be victims of crime (53).
- These tenant eligibility and architectural design problems were either lessened or eliminated in the Section 202 reauthorization in 1974 and subsequent amendments. However, the number of subsidized units that are available to the elderly remains woefully inadequate, and prospects for the future do not indicate a major increase in production. In most communities, waiting lists of prospective elderly tenants generally range from 1½ to 3 times the number of units that are available and often require a 5- to 10-year delay.
- Insufficient attention has been paid to the aging of the people who comprised the first cohorts of tenants in public housing and Section 202 projects. As the survivors among these early tenant cohorts become increasingly dependent for assistance in daily activities, their existing housing environments may be unable to provide the types of support required for independent living.
- Problems in the lack of supportive environments for the very old go well beyond federally assisted housing projects. They involve the even greater numbers of impaired or marginally independent elderly who are in unassisted independent housing in the community.

Because many of these housing problems for the elderly are generic, increased attention is being paid to policies that can encourage supportive environments for all older persons, whether in federally assisted or independent housing. The following sections discuss the variety of elderly housing options that exist in the community and suggest ways in which technologies can be applied to assist older persons in their housing environment.

The macro-environment of housing for the elderly

Although the various Federal housing programs provide subsidized rental units for about 1.5 million older persons (see table 33), approximately 90 percent of the elderly live independently in the community (sometimes called "nonprogrammatic" housing). As shown in table 26, over three-fourths of these elderly households are owner-occupied. This is due in part to other Federal and State policies (e.g., income and property tax laws) that have encouraged private sector housing development and private ownership of housing. Attitudinal surveys indicate that older persons who are in good health, and who can afford to do so, strongly prefer to maintain independent households (63,65). The prevalence of elderly, owner-occupied households—over one-fifth of all owned housing units—attests to this preference. Federal policy that either subsidizes elderly housing construction programs or supports older homeowners can directly influence the ability of older persons to remain independent and active in their communities—the macro-environment.

Characteristics of elderly single-family housing

The elderly have the highest rate of homeownership among all age groups. As in the general population, single-family housing predominates among these older households. Nine out of ten owner-occupied elderly units are single-family residences. But in contrast to the general population, elderly homeowners are notably more likely to live in housing that was built before 1940; 40 percent of elderly owners, but only 22 percent of nonelderly owners, live in units that predate 1940. Older houses tend to be less energy efficient, require more repairs, and have larger average room size than newer housing. It is thus more likely that older homeowners have greater housing repair and maintenance burdens than do younger homeowners (70). The very old are especially at risk of such burden, because they are most likely to be on fixed incomes and to be in the oldest housing. Many elderly homeowners avoid major home repairs. Undermaintenance is one of the most commonly used methods of "dissaving" (i.e., false economizing) by elderly homeowners, especially those living in houses that predate 1940. Avoiding maintenance or needed repairs is one way that older homeowners on limited incomes are able to continue paying for more essential goods and services.

These older homeowners are increasingly likely to be located in the suburbs of metropolitan areas,[17] especially those adjacent to central cities where the single-family housing stock is the oldest. As with the elderly who entered subsidized rental housing during the 1960s, homeowners in suburbia are also "aging in place." As suburban housing ages, increasing numbers and proportions of pre-elderly suburban homeowners are reaching age 65 and over. The rate of increase from 1970 to 1976 for all suburban households headed by an older person was more than three times the rate for central cities—31 percent in suburbia versus 10 percent in central cities. For older *homeowners,* the increase in suburbia was 36 percent, compared with 17 percent in central cities (27). These trends have continued into the 1980s and are not expected to change so long as ownership *and* maintenance of single-family houses remain economically practical for the majority of older Americans.

While suburban elderly homeowners and renters tend to have higher median incomes than their central city counterparts, there is little difference between them in the prevalence of chronic conditions, sensory impairments, and mobility limitations. Lack of an automobile or an inability to drive presents a greater burden for the elderly in suburbia, where the impact of minimal public transportation is made worse by the distances required to travel for essential services, shopping, and other routine tasks or needs. Maintaining the independence of the suburban elderly involves greater attention to their mobility problems outside the home environment. Recent estimates indicate that almost 1 million older persons (excluding about 750,000 who are homebound or bedridden) have mobility limitations in the macroenvironment beyond their immediate neighborhoods. Home health care and supportive service programs, combined with paratransit services for necessary trips outside the home, respond to the growing needs for assistance by elderly homeowners living in single-family suburban housing. The preponderance of single-person elderly households, even in suburbia, compounds this need for supportive environments and services.

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[17] A suburb is commonly defined to include all areas within a Standard Metropolitan Area that are outside the limits of a central city (as defined by the U.S. Bureau of the Census).

EXCESS HOUSING SPACE

The prevalence of single-family housing among the elderly also raises questions regarding excess housing space. While "overcrowding" is generally defined as greater than one person per room, no definitive criteria exist that objectively measure the existence of excess space or "overhousing." Overhousing is a relative concept that cannot simply be measured in terms of numbers of persons and rooms. For the elderly, lifecourse changes in family composition and living arrangements, and the consequent increase in proportions of single- and two-person households, are the primary reasons for excess space in existent housing. A suggested measure of overhousing incorporates an economic variable that compares one's existing housing space to the amount of space one would be willing to "purchase" at current rental costs (79). The comparison is made with renter households in similar income groups to assess the marginal utility of purchasing such excess space. One set of estimates based on this type of comparison using AHS data found that, in 1979, 2.3 million single-person, elderly owned households occupied five or more rooms. But based on comparisons with renter households of similar income levels, less than 500,000 single-person elderly households "should" have occupied that many rooms. According to these criteria, about 4 million elderly households (about one-fourth of the total) were considered overhoused in 1979. The proportions overhoused increased with increasing income levels and were notably more prevalent in metropolitan than in nonmetropolitan areas (79).

These data suggest the existence of a prospective pool of elderly homeowners who might consider alternatives to their current housing situation, as discussed further below. The feasibility of such options for the elderly will be based, in part, on the economic constraints (or advantages) of their existing housing, the cultural values that support single-family housing choices, and the marginal costs or rewards of changing one's existing housing.

SHARED HOUSING

Shared housing, or homesharing, includes a variety of living arrangements in which two or more unrelated individuals share a large apartment or house, as well as meals and some chores. Common living areas, including kitchen facilities, are shared; residents have private bedrooms and usually share semiprivate bathrooms. For many elderly homeowners, it is an ideal way to retain ownership, remain in familiar surroundings, reduce isolation, gain assistance with daily activities, and supplement a limited income. For homesharers, it provides less expensive housing in established neighborhoods, daily companionship, and an opportunity to help others.

Homesharing has occurred for decades on an informal and naturally occurring basis. Estimates from national survey data indicate that in 1980, 2.5 percent of all elderly households contained one or more nonrelatives (76). The U.S. Bureau of the Census estimates that up to 270,000 older persons are currently in some type of shared housing arrangement. With the recent growth in numbers of owner-occupied, single-person households among the elderly, greater attention is being given to promoting shared housing arrangements through matching programs sponsored by various social service agencies.

Notably successful programs include Operation Match in the Washington, DC, metropolitan area, Project Match in San Jose, CA, and Homesharing for Seniors in Philadelphia and Seattle. These programs are operated by local public agencies, federally subsidized nonprofit organizations, and local voluntary or religious groups. During the past 10 years, more than 200 shared housing units specifically for low-income elderly persons have been developed by community-based or religious groups. There are also an estimated 200 programs in the United States that currently provide individual homesharing matching services for the elderly.[18]

The projects range from agency-sponsored group homes that usually have 4 to 10 residents who share a large home to individualized arrangements that match an older homeowner with a boarder. In sponsored housing owned by an agency or private investor, the resident usually pays monthly rent in return for a private bedroom, private or semiprivate bath, meals, and laundry service. Limited transportation services may also be provided. Individual homesharing arrangements may be far less structured than agency-based group homes, depending on the needs and desires of the individuals involved. For example, the boarder can pay rent, provide services to the homeowner in lieu of rent, or some combination of the two.

For most types of homesharing, formal agreements are generally written to assure that no misunderstandings occur regarding the rights and responsibilities of the parties involved. The nature of homesharing makes the matching process an important and labor-intensive endeavor (17). Proper screening of applicants, both homeowners and sharers, requires intensive interviews and background checks to ascertain the expectations, personality traits, health, and economic status of the persons who apply. Homeowners might have unrealistic expectations about services to be provided by the boarder, while potential renters might not understand their responsibilities and constraints. A major goal of the matching process is to minimize possible conflicts and maximize a successful and enduring relationship between the homesharers. Mutually positive interdependence is a key factor in successful homesharing arrangements.

Properly developed and sustained, shared housing promotes greater economic and personal security for older homeowners, while providing affordable rental housing for other older persons or for younger individuals seeking temporary housing. Although far fewer in number, intergenerational arrangements are often successful because of the types of assistance that younger persons can provide in the home (e.g., chores, routine maintenance) and the stability and support that older persons can provide to young people. Whether intergenerational or intragenerational, homesharing arrangements may be particularly suitable at those times in the lifecourse when major changes have occurred. For older persons, widowhood, divorce, or other types of social support losses can be ameliorated by homesharing. For young persons just entering college or the job market, shared housing arrangements can provide an affordable and congenial living environment. Similar advantages are gained by older persons in intragenerational shared housing.

Another advantage of shared housing is its efficient use of existing housing stock, with no major construction or renovation costs (80). Communities can benefit from the expansion of affordable rental housing that homesharing provides, while preserving the single-family nature of the neighborhood. In essence, homesharing generally replaces family members who are no longer part of the household. Thus, it need not be viewed as a major cause of increased population density in residential neighborhoods or of significant increases in the need for public facilities and resources. An added communal benefit is the continued economic and functional independence of the community's older homeowners and the likelihood that homesharing will enhance the informal support system for those older persons who need assistance in the activities of daily living. When carefully developed and administered to maximize the likelihood of long-term matches, to assure the safety of all persons involved, and to retain the existing nature of the neighborhood, shared housing can benefit the old, the young, and the community at large.

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[18] Detailed information on such groups is available from the Shared Housing Resource Center in Philadelphia, PA.

HOUSING CONVERSIONS AND ACCESSORY APARTMENTS

A variety of housing options that do not involve a shared household are included in the category of housing conversions, all of which promote the use of existing housing stock. Most common among them are:

- extensive rehabilitation of abandoned residential dwellings to bring them in compliance with local zoning and safety codes;
- conversion of nonresidential buildings into multi-unit residential dwellings for the elderly; and
- conversion of existing single-family houses into dwellings with two or more units, or accessory apartments.

Each type of housing conversion has different benefits and constraints. Housing construction and design technologies can play a central role in the economic feasibility of such conversions, but local customs and zoning ordinances can be just as important to the possibility of their development (82). The attitudes of older persons for whom these conversions are intended also play a significant role in their potential success.

Rehabilitation of Abandoned Dwellings.—The feasibility of converting abandoned residential dwellings depends largely on the ability of community-based organizations to promote such projects. They are generally feasible only where government subsidies are available to organizational sponsors or where the real estate market is sufficiently strong for private investors to be involved. Government subsidies for this type of conversion usually take the form of low sale prices for abandoned buildings whose ownership has been relinquished to the municipality through tax delinquencies. Public auctions of abandoned buildings in need of rehabilitation generally yield low sale prices in return for commitments by the purchasers to renovate the building and bring it up to fire and safety codes. Conversion projects with organizational sponsors (e.g., religious or secular nonprofit groups) are facilitated by coordination with local public housing agencies or quasi-public housing development programs to assure that the conversions satisfy all local zoning and housing code requirements.

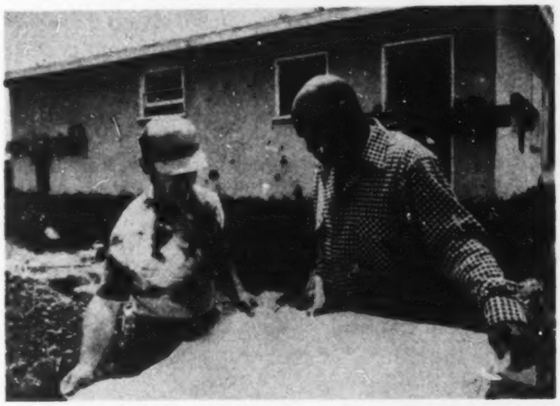

Photo credit: Suzanne Larronde

Rehabilitation of abandoned residential dwellings often requires government/private sector cooperation.

The economic feasibility of conversions for homesharing purposes is based on various factors. They include:

- tax credits or other incentives by local municipalities;
- applicability of modular construction technologies for such dwellings;
- lowered construction and rehabilitation costs in units with existing infrastructure (e.g., structural, electrical, and plumbing systems);
- cost savings from use of shared kitchen, living, and bath facilities;
- adequate rental income from multiple tenants; and
- assistance of local agencies in finding and selecting tenants.

While these inducements are strong, relatively few rehabilitation conversions of abandoned dwellings have been undertaken specifically for developing shared housing. The tenuous nature of the process and the limited availability of suitable locations or structures constrict the potential market for such conversions. Rather, abandoned dwellings have been more suitably converted by younger persons seeking affordable and conveniently located housing in central city areas. With relatively low purchase prices, abandoned residential dwellings offer home ownership opportunities to younger families who are able to invest time and labor to rehabilitate the unit.

For most homesharing purposes, such rehabilitation involves a degree of speculation that is generally not warranted unless a number of the incentives listed above are available. The key factors are economic feasibility and the existence of an organizational sponsor to promote and undertake this type of extensive rehabilitation for homesharing purposes.

Conversion of Nonresidential Buildings.—Since the early 1970s, when real estate values in both central city and suburban areas began to appreciate rapidly, older nonresidential buildings became feasible for conversion to multi-unit, high-density residential use. The rapid growth of single- and two-person households—both young and old—during the last two decades created a large pool of prospective owners and renters who prefer living in proximity to urban amenities, job locations, service agencies, and public transportation (59).

The changing economic and commercial basis of many central cities left older manufacturing and commercial buildings empty or underutilized. In some urban core areas, conversion of nonresidential buildings coincided with government-subsidized urban renewal programs that were aimed at revitalizing a central city's daytime commercial and nighttime entertainment and residential functions. For similar reasons as those noted in the previous section, the conversions were economically attractive to commercial developers. The 1970s were a period of rapid growth in "theme areas" of cities that catered to the young professional market of consumers for housing, retail facilities, and entertainment. The first era of conversions included the development of specialized shopping and entertainment facilities, followed by the growth in multi-unit residential dwellings. The latter were sometimes created from buildings that were warehouse or manufacturing facilities. Their solid structural, plumbing, electrical, heating, and other components generally provided a sound infrastructure that would have cost much more if newly constructed. Retrofitting of existing infrastructure components is one economic advantage of conversions. In general, older nonresidential buildings require weatherization, insulation, and updating of the heating and cooling systems. Their size and open spaces often permit considerable flexibility in designing interior units for residential purposes. Units for single- or two-person households, which might comfortably occupy from 800 to 1,200 square feet of space, are especially feasible in such projects.

The earliest multi-unit conversions were marketed for young urban households. However, as the proportions of older people in central city areas grew and their housing desires leaned toward smaller, more convenient, and affordable settings, the use of central urban buildings for rental or condominium units designed especially for elderly households also became feasible. Studies during the 1970s confirmed the potential of central city nonresidential buildings for providing new housing that was safe, responded to the needs of older persons for proximity to shopping, services, and public transportation, and provided a homogeneous residential environment with some degree of informal supports (8,60). Without government subsidies, the majority of these multi-unit rental buildings must cater to the elderly households that have moderate incomes. Elderly renters, who are most likely to have low incomes, are unlikely to afford such housing unless Section 8 or other subsidies are available to reduce out-of-pocket monthly costs. Even where Section 231 mortgage insurance was available to subsidize this type of conversion, the units developed were largely for "retirement centers" that rarely included low-income residents.

Thus, conversions of nonresidential buildings into units for the elderly are usually undertaken by profit-making developers and are generally targeted toward middle or higher income consumers. Compared to suburban areas, where the higher income elderly are concentrated, the central urban location of most nonresidential buildings limits the potential elderly market that is available. The indigenous central city elderly population is most likely to be poor and in need of rental housing. Thus, these conversions would be more feasible for poor elderly residents if government housing subsidies were available to promote the development of lower cost rental units.

Single-Family Housing Conversions and Accessory Apartments.—One of the more common types of housing conversion is the creation of an additional apartment within an existing single-family house. These are generally called "accessory apartments,"[19] to emphasize their characteristics as separate living quarters created within existing houses. The Census Bureau estimates that there are 2.5 million accessory apartments in the United States (18,77), although some sources would yield higher estimates (68). One reason for the lack of accurate data is the often circumspect nature of these additions, many of which violate local housing ordinances and zoning laws that only permit single-family housing in a neighborhood. Door-to-door surveys in single-family neighborhoods would undoubtedly yield greater numbers of such secondary units than are known to local authorities.

Conversion to an accessory apartment generally involves building a self-contained independent unit, usually with a separate entrance, that includes a separate kitchen, bathroom, bedroom, and living room. Although most conversions of this type are undertaken covertly because of existing restrictions in local housing codes, they are feasible because the exterior appearance of the single-family house remains unchanged. The accessory unit is often added in a basement or one part of a large home, with a private entrance from the side or rear of the house. Thus, most homes with these added units retain their single-family appearance.

While accessory apartments may be developed to provide rental income for an owner-occupant, the units are often developed to provide independent living quarters for a parent or other relative (hence, the term "mother-in-law apartment"). Recently, these units have gained attention as a potential source of added income for elderly homeowners. Given the degree of overhousing that exists among elderly homeowners,[20] especially single-person households in suburban areas, conversions to accessory units are an alternative to homesharing. This alternative may be more attractive to elderly homeowners who wish to retain their privacy and independence, and similarly attractive to potential renters (elderly or nonelderly) who would prefer separate living quarters at an affordable rent.

Today, conversions to create accessory apartments are more technically feasible than ever before, because modular room and wall units are available at somewhat lower cost and higher quality than many units built on site. Because the basic infrastructure for plumbing, electricity, heating and cooling, exterior walls, and interior walls already exists, the cost of conversion to an accessory apartment is generally much lower than the cost of constructing totally new units. Modular or factory-constructed bathrooms that include cabinets, bathtubs, shower stalls, toilets, and fixtures in one unit are available. Individual modular bathtub, shower, and cabinet units have also become increasingly popular. Onsite construction labor costs are usually lower for installing factory prebuilt units. Modular kitchens are also now available, some of which have integrated wall and cabinet systems that include all major appliances (23). The range of options in factory-assembled units permits flexibility as well as cost savings.

In the few communities where they have been studied, accessory apartments have generally been well-received by residents of all ages and socioeconomic levels (28). In one analysis of three suburban communities where accessory apartments have been permitted under local zoning law changes, about 12 percent of the single-family homes in each area had accessory apartments. Residents in communities with affluent homeowners were particularly pleased that persons were living in many of the houses while the owners were away for extended and frequent trips. It was also shown that homes with accessory apartments were *unlikely* to have a negative effect on neighborhood housing values, but absentee ownership of any type of single-family housing, either with or without an accessory apartment, was more likely to create lowered values (28). Thus, in some communities that legally authorize accessory apartments, the permits require that the houses be owner-occupied. Some communities also require that either the homeowner or the tenant(s) be age 65 or over. Such restrictions are intended to maintain the stability of the communities in which accessory apartments are permitted. Moreover, in the three communities studied, the average length of tenancy in the accessory apartments was approximately 5 years, a relatively long period for rental households.

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[19] Accessory apartments are also sometimes called "secondary units" or "mother-in-law apartments."

[20] Census data indicate that almost two-thirds of all elderly homeowners are part of one- or two-person households in homes with at least five rooms. This group numbers about 7.3 million elderly households.

These results may not always be duplicated, depending on the type of community and housing stock in which the conversions occur, as well as the general demand for rental units. In one demonstration program recently undertaken to convert two-story houses to duplex units, the results were mixed. The older dwellings in which the secondary units were constructed required more extensive rehabilitation and time than is the case for converting a basement into an apartment. Because it was a government-assisted demonstration program, there were numerous required approvals, resulting in delays in obtaining financial assistance. The older homeowners incurred debts and inconvenience for periods longer than anticipated. Because of their costs, these conversions required more years of rental payments to yield a net profit on the conversion costs incurred by the elderly owners. The results, while promising, would have been far better had the long delays not occurred (9).

Thus, while not foolproof, accessory apartments provide a likely source of additional housing for persons needing rental quarters, while also adding to the income of single-family homeowners. In most communities, secondary units neither change the appearance of the neighborhood nor detract from housing values. Because of these attributes, the potential for accessory apartment development is strong, but not until some of the myths surrounding this type of housing are corrected and public attitudes are changed. When properly developed and integrated within existing single-family communities, accessory apartments can directly benefit elderly households, both owners and renters alike. Continued growth in the number and proportion of accessory apartments in most areas of the United States, especially older suburbs, can be expected during the next two or three decades as demand for rental housing grows.

DETACHED ACCESSORY HOUSING: THE ELDER COTTAGE

Another housing option for the elderly is a relatively small, free-standing cottage that is factory-built and erected on a preformed foundation. These cottages are generally known as "granny flats," a term borrowed from Australia where the original units were developed. They are also known as "echo" (elder cottage housing opportunity) housing or, more simply, elder cottages. Granny flats are designed for installation in the side or back yards of existing single-family homes. Their potential use has grown as new construction technologies have improved their appearance, quality, and energy efficiency.

These small homes range in size from 500 to 800 square feet and contain one or two bedrooms. They are either totally built and assembled at the factory or built in modular sections that are easily assembled on the site. In the United States, one Pennsylvania company offers three basic cottage models that range in price from $15,000 to more than $22,000, plus foundation, installation, transportation, and utility connection costs (14). Factory production techniques using template guides for cutting and assembling all sections have improved the quality of the total unit. Exterior wall boards with high insulation value are usually combined with vinyl or aluminum siding, inner wall batt insulation, weatherstripping, magnetic door seals, and double-pane windows (and storm windows) to promote energy efficiency and comfort levels that are suitable for elderly persons. The modular construction of these homes includes all major kitchen appliances, cabinets, and bathroom fixtures. The modular units, or even an entire assembled house can be transported to the site, where the house is erected on a prebuilt foundation with all water and utility lines installed. The housing unit can be installed, and all required plumbing and utility connections completed, in 1 or 2 days.

Because elder cottages are intended for the elderly, door openings are designed for wheelchair accessibility; entry ramps in place of stairs are optional provisions. Although usually defined as "temporary" housing for zoning purposes (simi-

ELDER COTTAGE

Photo credit: The Coastal Colony Corp., 1983

The "elder cottage" is one example of a free-standing granny flat.

lar to mobile homes), elder cottages are constructed to last permanently. But they are designed to be easily disassembled, removed from the foundation, and moved to another site. Such technological and design specifications enhance their feasibility as temporary structures while maximizing the quality of the environment for those older persons who may have functional impairments and mobility restrictions.

Other technological advances can make factory-built elder cottages even more responsive to the *individual* needs and desires of older residents. New applications of existing computer design technologies could lead to the availability of consumer-designed housing that takes advantage of the economies of factory-built housing. An example is the "Burroughs house" in Sweden, which can be designed in sections as small as 4 feet by 8 feet. First, a normal blueprint is drawn to the specifications of the consumer. Then, an electronic pencil or eye traces over the blueprint, which is electronically sent to the factory where the modular units are constructed (35). In this way, elder cottages that respond to the desires of the residents could be individually designed (e.g., from a range of options for room size and layout), built at a centralized factory, and shipped to dispersed geographic areas. Given the limited size of the cottages, adapting the interior living space to meet the consumer's desires would give these units broader appeal and greater marketability.

As with accessory apartments, however, the greatest challenge to the development of elder cottages is resistance of local communities to this type of secondary housing in traditionally single-family neighborhoods. Local zoning restrictions are the key barriers to the spread of such housing. It appears, however, that some of the resistance is dissipating. In recent years, some States (e.g., California, Pennsylvania, Arizona, and New York) have enacted different types of legislation that "authorize" local communities to permit construction of granny flats in single-family neighborhoods or in rural areas. As the esthetic and physical qualities of elder cottages improve, local communities may be more likely to permit their construction. In communities where they are currently allowed, the rental of elder cottages is often restricted to family members. In this way communities protect themselves from development of accessory units that might become commercial rental property. Because granny flats are temporary structures, local codes often require that they be disassembled when the unit is no longer occupied by the family member(s). While such requirements preserve the limited scope of granny flats and increase their acceptability in single-family neighborhoods, the cost of removal (about $8,000) adds to their total cost and, therefore, reduces their feasibility.

According to existent information, communities that allow granny flats in single-family neighborhoods have had very few requests for permits (95). Where they have been built, no negative effects in housing values, esthetics, crowding, or other consequences have been discerned. Elder cottages, when carefully constructed to assure their quality and designed with roofing, siding, and other materials that correspond to the neighborhood's existing housing, can provide an economical, safe, independent, convenient, and supportive housing environment for older persons.

But the current market for granny flats appears to be very limited and selective, especially when contrasted with the millions of accessory units that have been constructed in the United States during the past decade. Even in Australia, where granny flats were first developed, less than 600 have been erected. In the United States, investment in construction of granny flats, despite recent advances in modular technologies, requires significant capital outlay, uses valuable open space, and usually includes restrictions on permanence of the structure. Conversion to accessory apartments requires fewer risks, lower costs, and less inconvenience. Thus, the relative advantages of granny flats over accessory units are difficult to ascertain, except in special circumstances where a detached unit is particularly desirable.

CONGREGATE AND ASSISTED HOUSING

Congregate or assisted housing describes various types of housing complexes that can be defined and described as service-integrated group living or assisted independent living. The term encompasses multi-unit complexes that provide their residents with some degree of supportive services, the most common of which is one or more meals served daily in a central area (7). The fundamental feature is a supportive environment that can be flexible in meeting the diverse needs of the elderly, especially as they reach the oldest ages when chronic conditions and impairments are more likely to limit their independence (see chs. 3 and 7). The ideal congregate housing setting follows the earlier-discussed model of environmental congruence. Flexibility is another ideal aspect, particularly the ability of the environment to meet the needs of the residents as they age. Congregate housing is thus considered to best approximate an accommodating environment whose supportive elements can be called on as the needs of individual residents increase over time and they require greater assistance in activities of daily living (6).

Publicly Sponsored Congregate Housing.—Until recently, the Federal Government has not been a strong proponent of supportive housing for the elderly. The traditional approach of HUD has been to concentrate only on construction of housing complexes through its subsidy programs for developers and renters—the so-called "bricks and mortar" orientation. But as demands grew for more supportive environments for those older persons who were in subsidized housing complexes (e.g., public housing, Section 202), HUD eventually entered into cooperative agreements with other Federal agencies to integrate social and long-term care services with physical housing programs. These funding initiatives have supported demonstration programs that provide a range of congregate services in Section 202/8 assisted housing for the elderly. The total effort is, however, small in comparison to the number of potential residents who could benefit from congregate programs and the range of services that could be provided to maximize the supportive nature of the housing environment.

As the proportions of old-old and very-old residents in elderly housing complexes grow (i.e., aging in place), numerous services in addition to daily congregate meals are usually required. Among these are medical and health care services, housekeeping and chore services, meals on wheels, increased security, transportation outside the neighborhood, education programs, and recreational activities. Ironically, reductions in Federal subsidies for congregate housing programs are occurring at a time when the older population is itself aging and the need for these supportive services is growing. The surviving members of the first cohorts of elderly residents in Section 202 housing are now the very old. Yet, the environments that 20 years earlier may have provided adequate safety and support for the young old have certainly become less "friendly" to these very old residents. Indeed, even the best efforts of the Federal Government in the current period of economic restraints would not meet the broad range of needs for this type of supportive housing environment.

In order to accommodate this growing demand for assisted living, new design features that promote the supportive nature of the physical environment can be combined with the provision of more services to help older residents remain in their current living environment. But there is no *single* Federal agency that is responsible for initiating, developing, and implementing this type of supportive housing environment for the elderly. Because of both the limited Federal involvement and the growing awareness of the elderly housing market, private developments aimed at middle-income elderly households have become increasingly prevalent, especially as current government subsidies for congregate housing are being reduced or eliminated. But most of these new units are beyond the economic reach of poor and near-poor elderly households who must still rely on government assistance to find adequate housing. A notable gap remains between the poor and nonpoor elderly in access to affordable living environments that provide a high degree of supportive services.

Privately Developed Residential Complexes for the Elderly.—The service-rich characteristic of congregate housing is exemplified by new, privately sponsored housing complexes that are popularly referred to as "life care communities," "continuing care retirement communities," or "residential care complexes." These communities typically consist of apartments in a congregate setting and/or single-family cottages in a cluster arrangement that most often include recreational facilities, a nursing home, acute care clinic, and a range of supportive services for their residents. A broad array of congregate services are offered, including daily meals, laundry services, homemaker chore services, and transportation assistance. Life care communities are established to encourage the continued independent lifestyle of the residents while also assuring them of long-term care (including nursing) and supportive services as the need arises.

Residential care complexes require an "entry" or "endowment" fee when the resident enters the facility, plus a monthly "service" fee that covers the unit's rental costs and those ancillary services that are included at no extra charge. The units are not purchased by the resident, but the entry fee "guarantees" lifetime occupancy. Most facilities also guarantee that the resident will receive all types of long-term care, including nursing care, without additional cost. Some facilities, especially those with lower entry fees, assess additional charges for services such as nursing home care. Although facilities may include acute care clinics, the charges for these services or for hospitalization (i.e., outside the facility) are borne by the resident in addition to the entry and monthly fees. In 1983, entry fees ranged from $20,000 to more than $100,000 for an individual (the cost for couples is usually 15 to 20 percent higher), while monthly fees averaged $600 for a single person and $850 for a couple (87). The large range in costs, especially for entry fees, reflects differences in the location, amenities, scope of services (particularly nursing home coverage), and sponsorship of residential care communities.

Current estimates indicate that about 100,000 elderly Americans are living in approximately 300 life care communities, most of which are operated by nonprofit organizations affiliated with religious denominations. This fact has made life care communities an attractive option because of the expected security and trustworthiness associated with these types of sponsoring organizations. The older person is investing a large initial fee on the good faith that the sponsor will provide the housing and all services during the resident's lifetime. However, some life care communities have already broken their contracts and some sponsors have gone into bankruptcy. In some of these instances, clearly fraudulent practices led to losses of lifetime savings for many residents. In others, the sponsors had underestimated the actuarial characteristics of prospective residents, resulting in higher than anticipated costs for supportive and nursing services for chronically ill residents. These costs were in excess of the income generated from the entry fee pool and the monthly fees (87).

One result of these failures has been the reevaluation of the actuarial assumptions for both morbidity and mortality that are used in determining fees. In many of the first-developed communities, new residents are paying substantially higher entry fees than earlier residents, and annual increases in monthly fees at some facilities have greatly surpassed the rate of increase in the general cost of living. As noted above, in some continuing care retirement communities, nursing home care is not included in the life care contract. Rather, the contract specifies extra fees that would be charged when the resident requires skilled nursing care or placement in the community's nursing home.

These adjustments in the costs and contract obligations of life care communities emphasize their newness and the need for the industry to more carefully develop such lifetime plans, which involve critically important actuarial projections (101). The elderly consumer is also warned to scrutinize the features of the life care contract, as well as the reputation and past performance of the sponsor. While the great majority of life care communities are successful and continue to provide the expected services, caution on the part of the consumer remains important in an industry that has few, if any, Federal or State regulatory safeguards.

OTHER TYPES OF CONGREGATE HOUSING

Two other types of congregate housing are particularly relevant to the elderly: nursing homes and board and care facilities. These types of housing are distinguished by the relative dependence of their elderly residents, as compared to those in life care communities or elderly housing complexes. The elderly in nursing homes and board and care facilities do not maintain individual dwelling units and have little responsibility for daily chores. This type of housing is often called "domiciliary," in reference to the types of personal care and protective oversight that are provided to the residents. Because the residents and characteristics of these two housing categories were discussed in chapter 7, they are only briefly reviewed here.

Nursing Homes.—In the United States, there are more than 23,000 facilities that provide nursing and related types of 24-hour care. Over 5,000 of these homes provide skilled nursing care. Currently, about 5 percent of the older population, or more than 1.3 million persons over 65, are residents of nursing homes at any one time. But about 20 percent of all older persons will live in a nursing home sometime in their lives. The elderly comprise more than 85 percent of all nursing home residents, whose average age is 83. Almost half of the total cost of nursing home care is paid by Medicaid, with additional small percentages paid by Medicare and by private insurance (about 2 to 3 percent by each).

The health, functional, and social characteristics of nursing home residents differ markedly from those of the community-dwelling older population. Nursing home residents are far more likely to be mentally impaired, to suffer from urinary incontinence, and to be dependent in eating, bathing, dressing, and other basic activities of daily living (99). They are also more likely to be widowed or single; hence, less likely to have informal support from a spouse or other family members.

Differences *among* nursing home residents are also discernible in terms of their length of residency. Recent studies indicate that between one-third and one-half of all nursing home residents stay for less than 3 months (i.e., "short-stayers"); about one-half of these persons died in the nursing home or shortly after discharge, usually to a hospital (47). Those who stay for 4 or more months are highly likely to be "long-stayers" who remain in the nursing home for well over a year. These individuals are far more likely than short-stayers to be mentally impaired and dependent in one or more basic activities of daily living (see ch. 7 for detailed characteristics of nursing home residents and the types of care they need).

The ability of nursing homes to respond to the many needs of their elderly residents depends in large part on the number of staff available, their training, qualifications, and experience in geriatric care, and their attitudes about elderly residents who typically have a high degree of dependency (91). These are crucial elements for quality of care in nursing homes. Another important factor is the living environment and its ability to provide psychological as well as physical support to the residents. Design and technological features that enhance safety, security, privacy, convenience, and attractiveness can promote the health and well-being of nursing home residents. Many of these features, some of which can also be incorporated in independent community-based housing, are described in the following section on micro-environments for the elderly.

Because nursing home residents typically have decrements in the senses, special attention to barrier-free environmental design is highly important. Declines in vision and hearing acuity of the average elderly nursing home resident require various adjustments in the physical environment that ameliorate the problems associated with these sensate losses. For vision, degeneration of the cornea can lead to severe loss of acuity, particularly in color discrimination. Peripheral field loss from retinal disease or glaucoma leads to "tunnel vision," resulting in poor orientation but generally good color acuity. Cataract and corneal disease result in varying degrees of clouding and distortion, with poor vision in bright light or areas with high surface glare. The effects of these conditions can be reduced by specific environmental adaptations. Heightened color intensity and contrast (e.g., accent stripping) would assist those who have peripheral loss, but such color cueing is generally not useful for persons with corneal degeneration. However, the use of oversized letters on nonglare surfaces and luminous, well-diffused indirect lighting will most likely benefit all persons suffering from vision loss. For those who are blind, raised letters, braille, and auditory cues are the obvious environmental requirements to reduce the degree of dependence of the nursing home resident.

Hearing loss, which affects about 30 percent of all older persons and a significantly higher proportion of the very old (who are most likely to be institutionalized), can also range from mild to severe.[21] Presbycusis (progressive loss of hearing due to various causes), tinnitus (persistent ringing in the ear), and other forms of hearing loss can restrict the ability of nursing home residents to carry on daily activities. For these persons, visual and tactile cues are helpful in managing environmental demands. Flashing lights to indicate when telephones ring or emergency alarms sound can provide an added measure of safety. Amplification devices for televisions, radios, and telephones increase their usefulness for the hearing impaired. Hearing aids that amplify sound at the outer ear are of limited value for many forms of hearing loss in the elderly, which are often due to neural degeneration in the inner ear that cannot be overcome by amplification in the outer ear. For persons with tinnitus, the characteristic ringing sounds may only be exacerbated by hearing aids. Background noise that interferes with conversational hearing can be reduced with appropriately placed carpeting, drapes, and other sound-absorbing materials.

Thus, more attention should be paid to visual and tactile environmental cues for the hearing impaired, especially those in nursing homes. Meanwhile, recent improvements in the technology of cochlear implants that restore very limited sound receptivity in the *inner* ear for deaf persons hint at possible future applications for large numbers of elderly people with hearing impairments caused by neural loss. These implants, recently approved by the Food and Drug Administration for use in the United States, hold promise for future application if their performance can be greatly improved and their cost reduced.

The general loss of tactile, motor, and ambulatory abilities among very-old nursing home residents is another area in which environmental design and technologies can provide assistance (39). Among the most common and least costly technologies are replacement of door knobs with door handles to greatly reduce the difficulty that many elderly persons have in gripping and turning door knobs. Door handles require less dexterity and twisting torque of the hand and wrist (19,40). They can also be used without gripping the handle; an open or closed hand, the forearm, or even an elbow can usually be used to push the door handle down. Similar problems with other types of fixtures are ameliorated by push-pull controls for plumbing fixtures and electrical controls (e.g., for persons severely afflicted with arthritis, toggle switches are far easier to operate than knobs).

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[21] Additional information on hearing loss among the elderly is provided in ch. 3 and in the forthcoming OTA Background Paper on *Management of Hearing Impairment in the Elderly*.

Other environmental technologies that are especially useful in nursing homes are changes in floor surface texture and color to denote differences in patient rooms, common areas, and staff areas. Nonskid surfaces and graspable handrails at proper heights for older persons and those in wheelchairs are low-technology applications that enhance the safety of nursing home residents. Safety grab bars, handrails, and raised toilet seats are also low cost but highly effective safety additions for bathrooms. In all cases, nursing homes can be designed to reduce the incidence of falls by avoiding steps wherever possible and using ramps to promote ambulation of patients and wheelchair access. Adequate indirect lighting, nonglare surfaces, and color cueing, as noted above, are especially important in these institutional settings.

Assistive devices such as wheelchairs are particularly relevant to nursing home residents, who comprise just under one-half of all users (84). But the technology of wheelchairs has changed slowly in recent decades, with most changes being refinements of existing features to make them more lightweight, durable, portable, and comfortable. For example, electrically self-propelled chairs have been refined to promote their safety, reduce their weight, improve the manual controls, and extend the length of time between battery charges. The next generation of wheelchairs will be the computerized version that permits the user to send instructions to the drive mechanism through a sensing device that detects specific movements of the head (61). The chair will also travel sideways as well as forward and backward. Its anticipated purchase cost is between $5,000 and $6,000, as compared with $400 to $900 for manual wheelchairs and $2,000 to $3,000 for regular power-driven chairs. As wheelchairs are improved and become more useful for greater numbers of older people, the potential number of wheelchair users in nursing homes should grow.[22] However, the purchase or rental costs of these improved wheelchairs may deter their use, in part because of limited Federal or State reimbursements for those costs and the need to medically certify that such technological advantages are warranted.

Regardless of market trends in high-technology wheelchairs, nursing home environments must accommodate the needs of all wheelchair users. Proper design of patients' rooms, especially to promote the independence of the wheelchair user in moving within the room, to the bathroom, into common areas, and in transferring from bed to wheelchair, is a fundamental requirement. As with other tasks, nursing home design should be predicated on the assumption that most residents are highly restricted in mobility and dexterity, thereby incorporating designs for extra-wide doorways, open cabinets, accessible shelves, closets with low racks, adjustable beds, and sturdy ergonomically designed furniture to properly respond to these physical limitations.

For the less mobile or self-sufficient resident, nursing homes can utilize other assistive devices. Nursing staff must often assist patients in transferring from bed to wheelchair and wheelchair to toilet or bathtub. Various portable lift devices are available that help assure the safety of the patient and the nursing staff in undertaking such tasks, especially when dealing with physically frail older persons in high-accident risk areas such as bathrooms. Similarly, electrically controlled beds allow relatively easy adjustments in vertical height and horizontal position to ensure the comfort, safety, and dignity of the patient. A number of other general design and device applications are useful in both the nursing home and independent housing. Most of these are noted in the section on the micro-environment of housing for the elderly.

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[22] One informal evaluation of wheelchair use among older nursing home residents attempted to determine why some persons who were still able to walk used wheelchairs. A frequently mentioned reason was that wheelchairs were far quicker than walking slowly, or using a cane or walker (22).

Board and Care Homes.—The category "board and care" includes a wide range of group homes that provide some type of supportive care to their residents. Estimates of the number of homes and residents vary greatly, because the definition of what constitutes such a facility remains nebulous. Indeed, of the 118 domiciliary care programs recently surveyed by the Administration on Aging, none identified their facilities as a board and care home (most used terms such as residential care or continuing care). In general, however, these homes are distinguished from other group quarters in that they provide room, board, and some form of *nonmedical and nonnursing* personal assistance. The latter is often referred to as "protective oversight" to emphasize the need for assistance with activities of daily living for many residents of such facilities.

Since each State individually licenses board and care homes, there is great variation in the types of facilities and resident populations that are included in national figures. The best estimate is approximately 30,000 board and care homes in the United States in 1981, with an additional 300,000 "boarding" homes in which residents primarily receive only sleeping quarters and some meals (92). An estimated 285,000 persons over 65 represent four out of every five board and care residents (72). As noted in chapter 7, these residents tend to be moderately dependent in basic or personal care tasks, and highly dependent in instrumental activities such as laundry, shopping, managing money, and cleaning. Board and care home residents also have above-average rates of poverty and mental impairment. Similar but less severe dependency seems to exist for residents of boarding homes (as distinguished from board and care facilities), but accurate national data are unavailable since boarding homes are generally not regulated or licensed. For that reason, it appears that boarding home residents are particularly vulnerable to fraud or abuse (62,75).

Because of their residents' characteristics, board and care facilities receive a significant portion of their income from residents who receive Supplemental Security Income (SSI) payments for the poor or disabled.[23] Those facilities that care for the more frail and dependent elderly (including those who are mentally impaired) are continually challenged to provide a decent, safe, and sanitary living environment for their residents. Many of the design features noted above for nursing homes could be incorporated in board and care facilities. But, because they are unlikely to receive Federal or State reimbursements for their services, board and care facilities are limited in their ability to undertake major physical changes in the design of the home. Thus, most facilities only meet minimum local fire and safety codes; few provide environmental features that encourage independence of the residents or promote a pychologically healthy and stimulating atmosphere.

Increased attention to the growing board and care population of older persons is needed if supportive housing opportunities are to be made more available to the elderly. In order to achieve this goal, the definition of what constitutes a board and care home could be standardized, as could be some type of Federal reimbursement or subsidy for costs incurred in caring for those who might otherwise be institutionalized. For the latter to occur, minimum design and safety standards for multi-unit homes could be promulgated to inspire healthier environments for elderly residents of board and care facilities.

The different types of congregate facilities briefly reviewed above attest to the growing variety of housing opportunities for most segments of the older population. Whether publicly subsidized or privately developed, congregate housing facilities are the most promising types of accommodative living environments for the elderly who have reduced or limited functional capabilities. Congregate facilities become more important as the average age of residents increases in multi-unit complexes designed for the elderly. Yet, there is no national system by which these housing opportunities are coordinated or the average consumer can be informed about them. The growth of private and public housing opportunities—ranging from accessory units to shared housing to comprehensive life care retirement complexes—will continue into the next century. As the U.S. population ages and the complexity of these housing opportunities grows, appropriate monitoring, regulation, and consumer protection will become more important.

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[23] When available, data from a 1984 survey of SSI recipients, undertaken by the Social Security Administration, should provide information on the levels of care available to SSI recipients in different types of living arrangements, including various types of board and care facilities.

The micro-environment of housing for the elderly

As noted in previous sections of this chapter, person-environment congruence becomes more important and more difficult to achieve as people age—another example of both the increasing heterogeneity and associated functional dependency with advancing years. The ability of the environment to accommodate and respond to the needs of its aging resident is often overlooked (41). It is usually assumed that what worked for persons aged 40 will provide the same environmental supports for persons aged 80. But this report has noted the changes in functional abilities that generally occur with increasing age and the need for appropriate responses to ameliorate the negative effects of those changes on the lives of older Americans.

The characteristics of the residential environment—its design, organization, and amenities—can have a profound effect on the ability of older individuals to function adequately on a daily basis (10,11). For purposes of this report, the "micro-environment" is defined as the immediate residential environment in which the individual lives, and includes the physical and esthetic elements that contribute to a person's quality of life. As expressed in the aforementioned HUD program goals, the micro-environment should provide safe, decent, and sanitary living quarters for all residents. For those older persons whose functional capabilities are reduced, these goals increase in relevance. Housing technologies and design factors can contribute significantly to providing not only the minimum standards for adequate housing, but an environment that fosters independence and promotes safety and convenience as well (21). This section reviews some general housing technologies that respond to these goals and provides examples of their applications in the home.

Technological applications in the home

New technologies for the home environment are continually being developed, many of which can add a measurable degree of convenience and safety to residents' daily lives. For the elderly with functional disabilities, some of these technologies can mean the difference between increased dependency on others for informal and formal support and the ability to maintain one's independence (5). The potential advantages are especially important to the growing number of older persons who live alone. It is not only the fear of being dependent, but also of not being able to seek help at critical moments that most concerns people as they reach the oldest ages. Technological applications in existing and new housing can provide a measure of security and safety that helps dispel these fears.

GENERAL IN-HOME APPLICATIONS OF TECHNOLOGY AND DESIGN

Among the many general technological or design applications in the home, a few low- and high-technology features stand out as the most important and feasible for the elderly, whether they are renters or homeowners. These are discussed in the following section.

General Safety Features.—Safety is a fundamental issue as persons age and functional disabilities become greater. Injuries and deaths from falls and fires are the most common dangers in the home life of older Americans. In the United States, the elderly account for one-fourth of all accidental deaths—more than twice their proportion of the total population. Falls are the leading cause of accidental deaths among the elderly. Indeed, persons over 65 account for more than two-thirds of *all deaths* from falls in the United States (15). The high risk of injury and death from falls has discernible implications for public policy; the economic consequences of falls in the elderly alone are estimated to be between $2.5 billion and $4 billion per year.

Risk of Falls.—There are a number of low technologies and simple design adaptations that, if implemented nationally on a large scale, would greatly reduce the risk of falls and their consequences for the elderly. Adding buffers to hard or sharp surfaces is one general approach. Properly installed carpeting, *appropriately secured* scatter rugs, upholstered furniture, and rounded edges on outside corners of walls, counters, tables, and other furniture lessen the likelihood of falls and the degree of injury when falls do occur. These measures may not prevent major injuries in older persons suffering from severe osteoporosis, but most elderly would benefit from such precautions. Care in the use of walkers, canes, and other ambulatory aids is necessary, since these assistive devices can themselves be the cause of falls. Abrupt changes in floor surface levels are dangerous, especially where there are no environmental cues such as changes in color or texture of floor coverings (15). A common example is the step-down room with a one- or two-riser step that is not easily seen by persons with reduced visual acuity. Another hazardous element in housing design is the door that opens directly onto a stair tread with no initial landing. The most common of these is found in standard house construction with doors that open directly onto basement stairways.

Stairs themselves are a major source of falls among the elderly. Most of these falls are due to tripping rather than slipping. The major problem is inappropriately designed or marked stair treads and landings. Elderly persons with arthritis or other causes of restricted mobility and agility have difficulty with normal riser heights when ascending a stairway. Reduced agility in the joints increases the risk of catching the front of the foot on the stair tread extension, or "nosing" (the portion of the tread that extends beyond the vertical riser), creating a forward fall on ascent. On descent, the short depth of the stair tread often results in "overstepping," which usually leads to a backward fall against the stairway. Deeper treads (11 inches is ideal) with lower risers (6 to 7 inches high) are the best environmental solutions to this problem. Another risk factor in stairway falls are handrails that are inappropriately designed or installed at the wrong height for the average older person. Because the average older person has lessened ability to grip large surfaces, handrails should be small in circumference and designed to fit the partially closed palm. Their ideal height is 36 inches, the same as that for door handles and electrical switches. Stair safety is also enhanced with tread edge markings on both the bottom *and* top edges of the stair tread. Falls due to overstepping on descent are due not only to short tread depth but also to the poor visibility of the tread edge when looking down from above. A mixed blessing is provided by nonslip strips for stair treads. While they reduce the chance of slipping, they sometimes create forward falls when the foot stops abruptly on descent. Carpeted stairways should be carefully secured at all edges, especially at the nosing and the back of the stair tread. In all cases regarding stair safety, proper illumination will minimize glare, reduce confusing shadows, and maximize tread edge visibility.

A considerably more expensive technology is the chair lift. It entails a fairly expensive addition to the home, requiring a well-anchored glide track along one side of the stairway, on which an electrically powered chair moves. In some States and local jurisdictions, electric chair lifts must conform to local building codes, generally those that apply to elevators. Depending on type of model and width of stairway, the basic cost of a chair lift for a straight stairway ranges from $2,200 to $3,500. Stairways with bends and landings add to the complexity and cost of this technology.

Other general safety features to prevent falls in the home include the removal of thresholds across door openings to reduce the likelihood of tripping. This hazard is often overlooked, but can be especially dangerous when adjoining surfaces are slippery or of contrasting texture. Added danger occurs when a threshold abuts loose or frayed carpeting, which increases the risk of tripping. The elderly, in particular, should avoid high gloss flooring that can be slippery when wet and unforgiving on impact from a fall (e.g., ceramic tile floors).

Risk of Fire.—Fire safety is a second major concern in the elderly's living environment. Although local fire codes vary, institutional settings and multi-unit residential complexes are generally required to have fire retardant and nontoxic materials wherever possible, smoke detectors, full sprinkler systems, accessible fire extinguishers, and fire alarms with flashing lights as well as bells or sirens. Clearly marked exits within specified distances from any resident's room, fire-resistant metal entry doors for all rooms, alarm-activated firebreak doors in hallways and common areas, and battery-powered emergency lighting are also generally required. Inspection and enforcement of these types of fire code requirements remain a problem in many communities, especially those with high proportions of older institutional dwellings that were constructed before such codes were developed.

Building requirements are far less stringent for single-family residences. Local jurisdictions are increasingly likely to require smoke detectors in all new construction and retrofitting in previously built multi-unit complexes or in single-family units that are sold. Because the elderly are highly vulnerable to injury or death from fires, added precautions are especially relevant in their microenvironment. Fire safety would be enhanced with emergency lighting, maximal use of fire retardant and noncombustible materials, and smoke detectors with alarm buzzers and signal lights. The detectors should be installed in all hallways, adjacent to bedrooms and the kitchen, and in basements. Hand-held fire extinguishers in strategic locations (e.g., bedroom, kitchen) are an additional safety measure. Where feasible, safe egress through windows can be enhanced with step stools to reduce the risk of falls in attempting to climb over a sill.

Fire prevention is improved by behavioral precautions. Avoidance of smoking while seated in upholstered furniture and in bed are fundamental prohibitions. Care in the use of all appliances is also important. For those who may be forgetful, self-monitoring appliances are a recent advantage. An example is the iron that shuts itself off if overheated, tipped over, or left in one position for a preprogrammed time. Similar technologies are becoming available for major kitchen appliances such as range tops and ovens (see subsection on kitchens).

Emergency Response Systems.—General safety features go beyond those related to preventing falls and fires. Electronic emergency alarm systems (e.g., "Lifeline") are increasingly available at reasonable cost. The most common type utilizes a personal transmitter that is either hand-held or worn on the body, usually on a belt or as a pendant. In an emergency, as in a fall or heart attack, the transmitter can be activated to send a signal to a central home unit that is interfaced with the telephone. The home unit then automatically dials a centralized control center that is monitored either by a person or a computer at all times. Most central monitors are currently located in hospitals or in residential care facilities. In many systems the emergency auto-dial unit includes a "line-seizure" mechanism that automatically takes over a phone line that may already be in use for a normal call. The central computer can receive several calls simultaneously; it automatically decodes each call to identify the home from which it came and records the time and date of the emergency call.

State-of-the art systems also have special signal codes to indicate the type of emergency involved (51). The signal codes indicate whether the source of the signal was the transmitter (most likely indicating a fall, heart attack, or similar episode), the emergency button on the auto-dialer unit (suggesting the person is ambulatory), or a smoke detector or appliance (indicating excessive smoke or fire). The central monitor automatically dials the home unit to confirm that it was activated, at which time the monitoring staffperson calls the home number. If the phone is not answered within a specified time or number of rings, then the appropriate emergency assistance is contacted.

The sensitivity of the system and the possibility of accidentally relaying a signal require care in the use and monitoring of all calls. Some systems are programmed to internally verify daily that the system is not malfunctioning by automatically dialing each home unit to assure it is working. The home units also have automatic battery operation in the event of power failures or if accidentally unplugged. When in the battery-powered mode, a signal is sent to the central computer and the staff monitor will then call the home to ascertain the problem.

These emergency response alarm systems can be installed in most homes and are especially valuable for persons who are prone to heart attacks or other acute episodes. In some communities, hospitals encourage their use as one element of discharge planning. Monthly charges for these types of service begin at $35 per dwelling unit, depending on the complexity of the system (46). Available information suggests that emergency response systems are of great value to those elderly who are most vulnerable: those with a history of acute illness and who live alone. Physical safety and the feelings of security that assistance is readily available are the most commonly cited benefits that these systems provide for elderly users who consider them well-worth the cost.

Telecommunications Safety and Convenience Devices.—Along with response systems for emergencies, a new generation of high-technology telecommunications devices are being developed that provide a much wider array of services oriented toward home safety, security, and convenience. One example is a system that employs microprocessors linked to one or more telephones to gather and monitor information provided by sensors located throughout a house. These systems (e.g., "Sensaphone") can monitor the home's heating, ventilation, and air-conditioning around the clock and automatically change room temperatures by preprogrammed instructions. The system also monitors the home's electrical use, its appliances, and possible sources of inefficiency. Loud sounds emanating from any room that has a sensor can be detected. The most sophisticated units can also use infrared detectors to discern, at predetermined periods of time (e.g., at night), movements inside or outside the house, or windows or doors that are opened. These security detectors can be linked with automatic dialers, similar to the emergency response systems, to notify authorities when assistance is needed.

Other telecommunications devices are creating opportunities for home-based safety or self-health care instruction (see ch. 6). Although in its infancy and relatively expensive for most residential applications, interactive telecommunications may soon replace programmed videotape or computer disk instructional devices (73). One-way information systems are generally known as "teletext" services. These involve television signal broadcasts of information that are accessible to individuals at home through a home-based decoder. With the appropriate keypad, the user can select the programmed information for viewing through the television. Teletext currently offers viewers a variety of programs in news, sports, entertainment, health instruction, consumer information, and other services.

Interactive systems with two-way communications are in their infancy. They are generically called "videotex" systems. These two-way information systems will offer a range of services in one unit. News, shopping, and banking services by telecommunications are expected to be the first applications for general in-home use (73). Videotex not only provides one-way information, but also allows the user to respond through the network system, which usually involves telephone or cable television lines (or a combination of the two). Community-based trials have demonstrated the usefulness of videotex in providing home-based electronic "catalogs" of consumer goods and in ordering merchandise through a home terminal. Videotex is a limited form of a comprehensive computer system that will automatically monitor and run all major aspects of the modern home—the "smart house" of today. These features are only the "first generation" of a new technology that may have significant impacts on the way people work, shop, and play in the future.

For the functionally impaired elderly, such systems offer new opportunities to maintain their independence through home-based information retrieval, teleshopping, and banking. Other potential applications include the ability to monitor a patient's vital signs and communicate them to a clinic or physician's office (26). The patient would in turn receive information from the physician. Interactive communications of this type may reduce the burden of difficult trips for medical examinations.

Pharmaceutical prescriptions also may be transmitted through this system, which could include detailed records of all prescribed and over-the-counter drugs being used by the patient. Indeed, the problem of "polypharmacy" (see ch. 5) in the elderly has grown as the population has aged and more drugs have become available. New methods to monitor drug intake would reduce the likelihood of negative side effects from improper combinations of drugs. Computer-based monitoring systems could also be used to "read" a patient's pharmacy records stored on a microprocessor embedded in a magnetic strip of a plastic card that can be carried by the patient. The magnetic strip would be machine-readable and accessible to any physician or pharmacist, who would regularly enter new data about the patient. This type of monitoring could significantly increase the safety of pharmaceutical decisionmaking by helping assure that a patient is not receiving improper combinations of drugs.

Currently, these types of telecommunications systems are in development and trial phases. The expense of the technologies and their specialized components make them impractical for general use by most older persons. But they hold promise for future applications that are clearly suitable for the elderly. Contrary to some negative stereotypes, older persons are both willing and able to learn how to use telecommunications equipment (13). The key factor in the learning process for the elderly is the functional advantage that the computer provides, whether for instrumental or entertainment activities. Older persons are also more likely to welcome computers if the keyboards have larger keys and the display screens are enlarged and their glare reduced. If they perform useful functions at reasonable cost, personal computers will be used by older persons, even nursing home residents who have moderate mental and physical impairments (20,97). Thus, as they become more affordable and user-friendly, home computers and other telecommunications devices should grow in popularity and accessibility among the elderly.

The Kitchen.—Microprocessors also have had a valuable impact on kitchen safety and convenience for the elderly. New appliances provide various programmable functions to assure that foods are both preserved and prepared appropriately. Touch-sensitive controls eliminate some of the problems that arthritic older persons have with knobs or dials. But these new controls tend to have poor features for the sight-impaired. Lettering and numbers are generally too small and of limited contrast for easy viewing. On the other hand, the ability to better control temperature settings and to use timing features make these appliances more convenient and safe. Whether "soft touch" push pads or dials, appliance controls for the elderly should assure sufficiently large lettering and should be located at the front of the appliance; never on the back panel. On ovens and ranges, for example, controls on back panels are more difficult to see and present greater danger of burns from contact with heating elements or flames.

Wherever possible, design elements that respond to the characteristics of the elderly should be incorporated in kitchen designs. Ovens and ranges should be located at counter height to minimize bending and reaching (19). Small countertop ovens are particularly convenient because they are at the correct height and are often the most efficient size for preparing one- or two-person meals. Other low-technology or design factors that add to the convenience and safety of kitchens include roll-out shelves in base cabinets, bottom shelves that are at least 10 inches above the floor (4 inches higher than normal), turntables ("lazy Susans") in corner cabinets, and rounded edges on all counter and cabinet edges. For the average older person, ideal counter heights are 32 to 35 inches (about 3 inches lower than most counters) and the bottoms of kitchen sinks should be approximately the height of a person's palm when standing. Counters and cabinets should be approximately 2 feet deep for ease of access to items on shelves. Maximum height for the highest shelves should be 70 inches. Nonglare lighting over counters and sinks adds safety to food preparation.

Various assistive devices also promote the ability of impaired older persons to function independently in the kitchen. These include electric can openers, jar cover openers (mounted under a

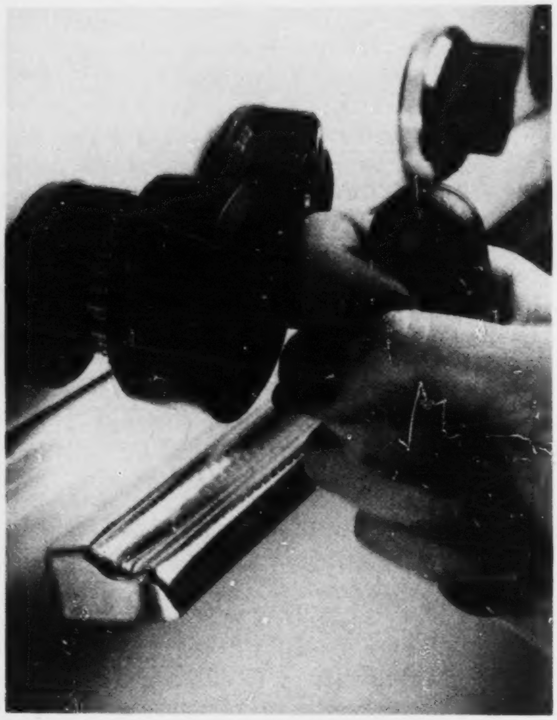


Photo credit: Comfortably Yours, Maywood, NJ

Turning handles can be used on appliance and faucet knobs to enhance an older person's grip and leverage.

counter or hand-held), special grip enhancers that fit over handles of pots and pans, food preparation timers with large numerals, and long-handled "reachers" (similar to those used in stores) for getting hard-to-reach objects.

The Bedroom.—One of the simplest changes in bedrooms is to raise the height of the bed for easier access and egress by older persons with limited joint mobility. Bolster rails that can be securely fastened to either end of the bed frame rails promote safety in getting in or out of bed. Nightstands should be slightly higher than the bed and lighting switches should be at the base of table lamps or mounted above the head of the bed. Touch-sensitive, metal base lamps are another convenient option. A telephone should be within easy reach from the bed, as should any emergency response transmitters.

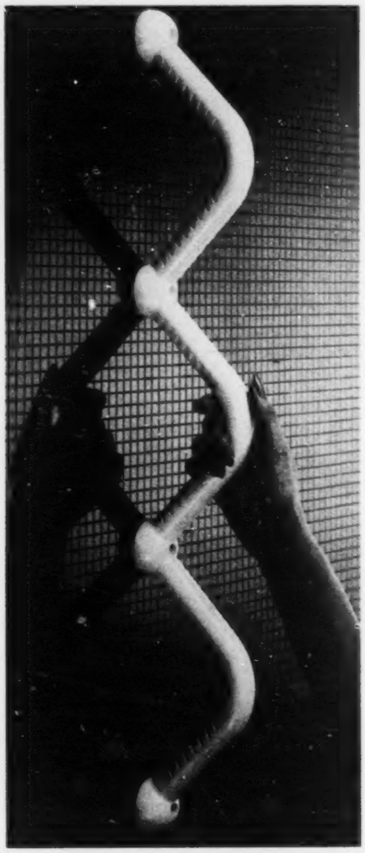
As in all rooms, scatter rugs should be securely anchored or have nonskid backing. Closets are more convenient with track-sliding doors, dual height clothes rails, open shelves from the floor, and roll-out drawers for selected items. Design features that minimize the need to bend, stoop, or reach should be the guiding principles in bedroom design for the elderly (55). Simple devices also are available to assist older persons in dressing. Among the more common are long-handled zipper pulls, hand "extenders" for pulling on hosiery, and the use of "Velcro" fasteners instead of buttons or zippers.

The Bathroom.—The bathroom is one of the most dangerous areas in the micro-environment of the elderly. Bathrooms are a frequent site of falls by the elderly and the characteristic hard surfaces contribute to the severity of injuries. More attention has been paid to promoting safety for the elderly in bathrooms than in any other part of the micro-environment (38). Numerous low-technology adaptations to existing bathrooms are feasible. Among the most common and worthwhile is installation of strategically placed and *well-anchored* grab bars on a bathtub's inner and end walls (using counter-sunk bracing), and over the outer side (with U-shaped, "locking" extenders). Grab bars should be made of stainless steel or high-impact heavy gauge plastic. Bathtubs should have nonskid surfaces; newer tubs are manufactured with such surfaces, but older ones usually need nonskid strips or rubber mats.

Adjustable shower heads that move 2 to 3 feet along a vertical glide rail are convenient for older persons who have mobility and dexterity impairments. Push-pull or lever types of controls for water mixers and shower diverters are more convenient than other types of fixtures. Tub chairs that have adjustable heights, secure backs, and nonslip leg tips are recommended for those who find it difficult to remain standing for a shower or to rise up from a bath. For the more severely restricted, tub chairs with side transfer seats are available as well. Another option is a step-in shower stall made of molded fiberglass that includes a sturdy, built-in seat and movable shower head (57). All bathtub and shower areas should be well-illuminated.

Use of the toilet can be made safer by adding assist rails on either side to help prevent falls. As with the bed, some older persons have difficulty in sitting on or rising from the average toilet seat height of 16 inches. Various types of adapters are available to increase the height from 2 to 5 inches to ease this problem. Unless there is an emergency response system, a telephone or other signal device that can be reached from the tub or toilet is advisable for older persons prone to falls, dizzy spells, or heart attacks. Tiled or linoleum floor surfaces in bathrooms should be kept as dry as possible to minimize the risk of slipping. Ideally, bathrooms for the elderly should have well-secured wall-to-wall carpeting or large scatter rugs with nonskid rubber or vinyl backing.

Many of these features represent adjustments to conventional bathrooms. New bathroom designs based on ergonomic principles and design standards could be a major step forward. Some attempts have been made to undertake such studies and designs, but to date none have become generally available to the public. A model bathroom for the elderly and handicapped has recently been developed by the Design Research Cen-



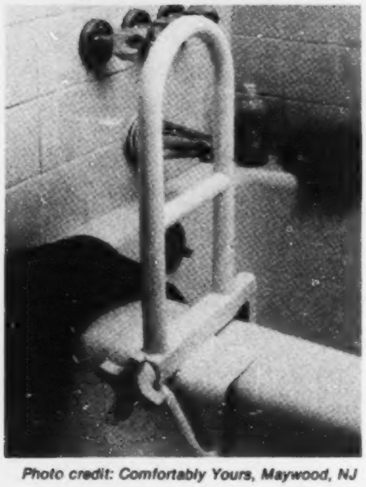


Photo credit: Comfortably Yours, Maywood, NJ

Well-anchored grab bars for bathtubs are an important safety feature for the elderly.

Photo credit: Comfortably Yours, Maywood, NJ

Properly installed assist rails for toilets can be adjusted for appropriate height and width.

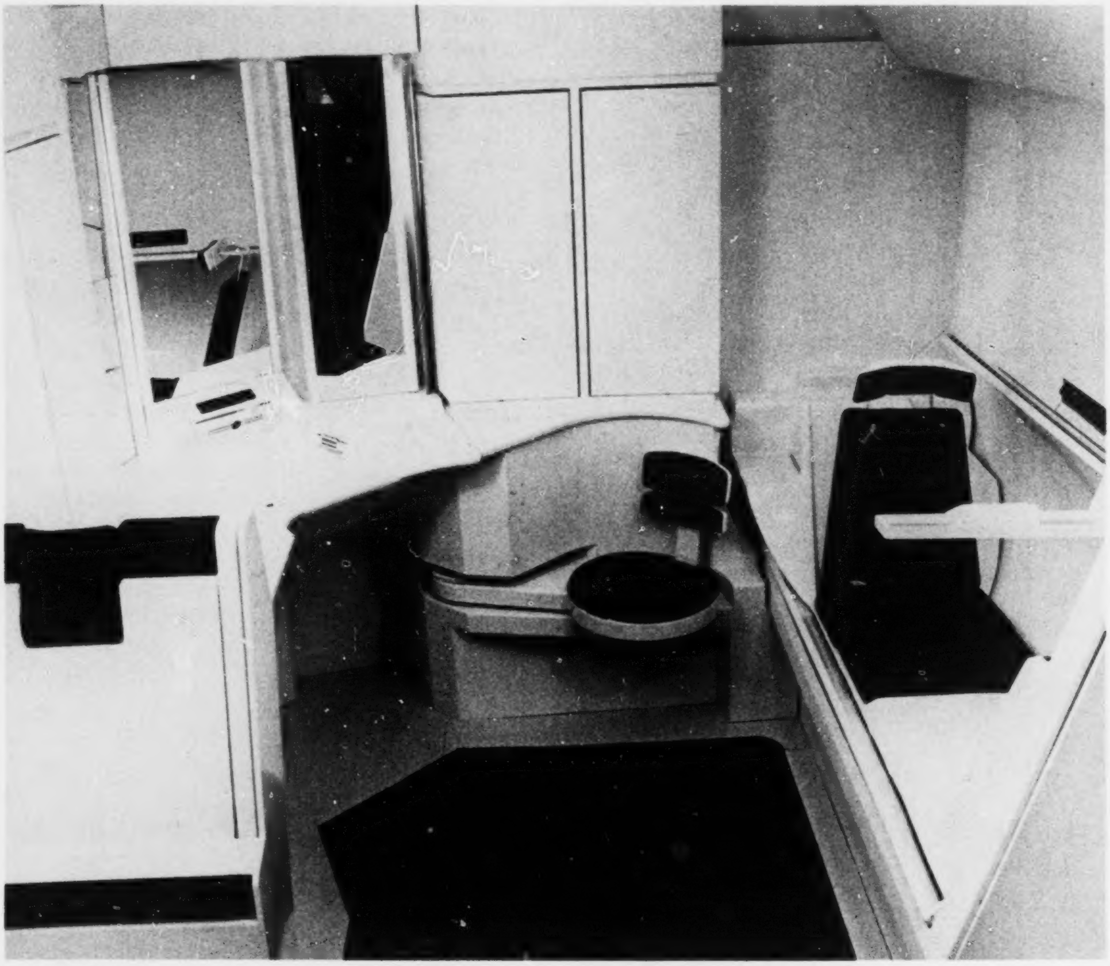


Photo credit: Design Research Center, University of Wisconsin-Stout

Prototypes of new bathroom designs are intended to promote the safety of older persons.

ter at the University of Wisconsin-Stout. As shown in the photographs, the design is unique and attempts to provide a far more user-friendly environment for the elderly. Lighting is indirect and nonglare. All hard surfaces are rounded and the entire room is carpeted to cushion falls. The color of the carpeting contrasts with the walls and fixtures to promote orientation for the visually impaired. The configuration of fixtures and the sturdy swing-out chair permit use at the sink and for transfer into the nonconventional bathtub. All shelves are within easy reach of the seated or standing person; the need to bend is eliminated.

The bathtub represents a significant departure from conventional design. Rather than require an older person to step over the normal 13-inch outer side of the tub (with or without grab bars), the Wisconsin design allows a person to sit in the open-sided tub, which is at chair height and has a built-in padded seat and back support. The bather sits, raises his legs, and rotates his body into the tub, much like getting into bed. A horizontally movable grab bar is used to raise the tub's circular outer side. This "bathing tube" is the enclosure for the water, which enters from shower heads above or a recessed "fountain" (i.e.,

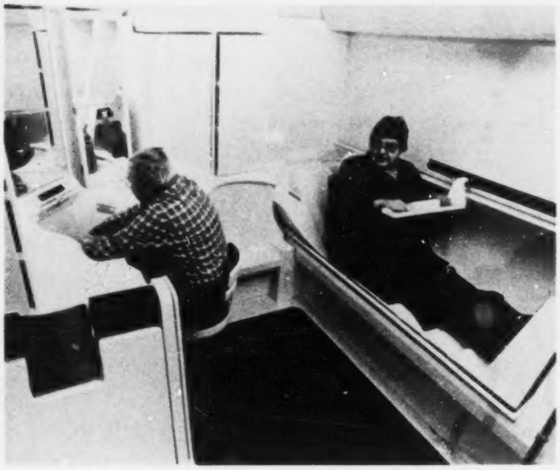


Photo credit: Design Research Center, University of Wisconsin-Stout

The prototype bathtub design reduces the risks of falls from slipping and bending.

faucet). Push-pull and slide controls for water volume and temperature are located on the grab bar, with an auxiliary set at the foot of the tub that can be operated with the feet. The recessed fountain allows the bather to test the water temperature before turning on the shower heads. When finished bathing, the water drains out around the base upon which the person is seated (or reclining) and the bathing tube side slides back into the unit so the bather can swing out to the seat or step onto the floor.

The other unique design idea is a toilet that keeps the body raised higher than in conventional units. The seat is placed at an angle that permits the user to maintain a squatting position that aids in defecation. A swing-down support bar opposite the seat provides additional safety and comfort. The angle of the seat is also more convenient for male urination. The Center has developed alternative designs for toilets, including a simpler one that involves a hydraulic-assisted seat to aid in lowering and raising one's body, along with side support rails for added safety.

While these bathroom designs have not been adopted commercially, they hold promise for further investigation and modification. For example, recent marketing for newly designed tubs stress built-in back supports and recessed fountains in place of potentially dangerous faucets that extend into tubs. The University of Wisconsin designs and technologies represent a conscientious attempt to create a safer and more friendly environment in the most hazardous room for older persons.

The Living Areas.—Numerous environmental design adaptations have been mentioned above that apply throughout the home. Loose and frayed rugs are particularly dangerous, as are glossy or slippery floor surfaces. Door handles, recommended for all nursing homes, can be quite expensive to install in one's home. But there are available a number of adaptive handle-shaped devices made of metal or plastic that can be snugly fitted over existing door knobs to provide the needed lever action. Numerous specially designed utensils such as scissors, gardening tools, screwdrivers, eating utensils, and writing implements have extra-large and slightly curved handles to aid in gripping. Plastic, rubber, or high-density foam pieces that can be slipped over the handles of regular utensils are a less expensive alternative.

Upholstered chairs with hydraulic or mechanical lift mechanisms under the seat cushions aid those with joint motion difficulty in sitting on or rising from the chair. Telephones with large buttons and adapters for controlling the volume in the hearing piece are commonly available. Energy-efficient windows with crank handles allow ease of use for ventilation as well as passive solar heating. In fact, an important element in housing design for the elderly is energy efficiency and safety in monitoring the heating and cooling systems to prevent conditions that lead to hypother-

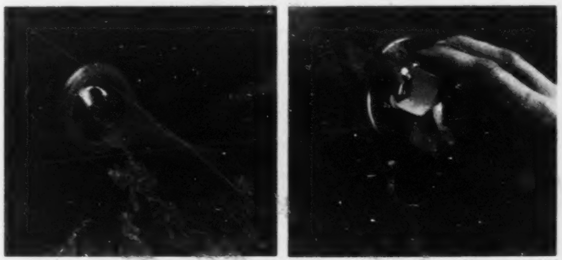


Photo credits: Comfortably Yours, Maywood, NJ

Various door knob adapters can be used, including ones that convert knobs into handles or provide grooved grip-enhancers.

mia or hyperthermia, to which the elderly are particularly vulnerable.

Numerous other housing design elements, low-technology adaptations, and high-technology systems could be discussed (58,67). Clearly, the individual can do much to foster a safer and more convenient micro-environment without excessive expense. He can also invest considerable amounts to develop a computer-based living system that performs a multitude of functions—the so-called "smart house" that would combine systems such as Lifeline, Sensaphone, teletext, videotex, and other microelectronic applications into a total integrated system.

Other recent high-technology applications are in robotics, which are primarily being applied in manufacturing (see ch. 10). Also being developed are robots that perform various household functions. The current prototypes are most useful for assisting severely impaired persons such as paraplegics. However, even the most well-developed robots today require considerable programming to perform basic tasks. Experimental (and costly) mobile robots exist that can respond to selected voice commands and perform a limited range of functions. Further development of these prototypes could lead to a time when they become much less expensive, far more appropriate for tasks of daily living, and generally available for use in the average household.

Whether the issue is high-technology robots, home-based computers, housing design elements, or low-technology adaptations and assistive devices, there is a need for greater public awareness of the possibilities for promoting the functional independence of the elderly. At the same time, the network of public agencies and private organizations involved in the field of aging could also be better informed. Finally, the private manufacturing sector should be made more aware of the significant and growing market for products and services designed to meet the environmental needs of the elderly.

Concluding remarks

This chapter has reviewed the broad range of factors that have an impact on the housing and living environment of the elderly. As the older population itself ages, the proportions of older persons living alone, experiencing housing problems, or dealing with functional impairments are likely to increase during the next three decades. New responses to assist the elderly in maintaining their independence will be needed if the projected increases in nursing home populations are to be kept at a minimum. The maintenance and energy burdens of older housing tend to fall on those elderly homeowners who are least able to pay those costs, while elderly renters (who tend to be poor) are faced with both shrinking housing opportunities and rising rental costs. These trends are occurring at a time when Federal housing programs and subsidies are being eliminated or curtailed. The elderly and the poor are the two groups that are most vulnerable to these changes in Federal support for housing.

The growing need for congregate housing facilities presents opportunities for public and private involvement across a range of housing types that can respond to the heterogeneous characteristics of the older population and their needs for supportive living environments. Excess housing space can be better used to serve both elderly homeowners and those seeking decent, affordable rental housing through developments such as shared housing, accessory units, and granny flats. Board and care facilities may become more important in providing both housing and protective oversight to many older persons who do not require skilled nursing care. The many types of life care and residential care communities being developed attest to the market for this kind of macro-environmental support. The cost of such housing opportunities varies greatly, depending on sponsor, location, and services provided. But the physical and psychological security provided by congregate facilities responds to one of the major concerns of persons as they age. Maintaining one's independence, promoting a healthy lifestyle, and being assured of long-term care and supportive services are the key attractions of residential care complexes.

Opportunities to remain independent in one's home are also possible by attention to adaptations, design factors, technologies, and behaviors that promote safety and security. These range from nonskid treads and appropriately designed stairways to "smart" appliances and totally new bathroom designs. As with all aspects of technology, their possible applications in the micro-environment of the elderly will depend on their usefulness, cost, and adaptability in existing living environments.

Research priorities

The following items, while not exhaustive, indicate the types of research on housing and the living environment of the elderly that would be beneficial in development of public policy:

- accurate assessment of the functional abilities of older persons in tasks of daily living, the physiological bases of functional impairments, and the range of adaptive behaviors that are developed to compensate for limitations in functional ability;
- changes in household composition of the old-old and very-old subgroups of the elderly and their implications for future demand for formal and informal supports in the living environment;
- attitudes of the elderly and nonelderly concerning the types of housing opportunities that should be available and the respective roles that can be played by the government and the private sector in providing those options;
- housing problems confronting elderly renters and mortgaged homeowners who have household incomes below or near the Federal poverty level;
- the market for the full range of elderly congregate housing facilities and strategies for promoting their development, including a wide array of accompanying services;
- ways to promote development of new models and designs of living environments for the elderly that better respond to their physical capabilities as well as their limitations; and
- development of improved projections of changes in household composition and housing demand of the older population, and ways by which this demand could be met.

Issues and options

ISSUE 1: Should the Federal Government expand existing programs that assist low-income elderly homeowners who have excessive housing deficiencies and excessive cost burdens?

Options:

1.1 Congress could avoid making changes in current programs that assist this subgroup of older homeowners.

1.2 Congress could mandate additional investigation of the housing problems of poor elderly homeowners and the ways in which these problems could be mitigated by the Federal Government. Particular attention could be focused on possible biases against homeowners living in small communities in metropolitan counties that are not likely to benefit under CDBG or Section 312 programs.

1.3 Congress could appropriate significant funding increases in the Section 312 program (perhaps in conjunction with the Community Development Block Grant program) that provides low-interest loans to qualified homeowners for rehabilitation *of their housing. This expansion could greatly increase the number of loans available and/or increase the subsidies for lower interest rates on such loans. The subsidies could be modeled after the interest credit provided under Sections 502 and 504.*

1.4 *Congress could amend the Section 312 rehabilitation loan program to permit outright grants or interest-free loans to low-income elderly homeowners for removing physical deficiencies in their housing. Other amendments could broaden the availability of the loans to areas that may not have CDBG or urban renewal programs.*

1.5 *Congress could legislate new amendments to the Internal Revenue Code to permit tax incentives (deductions or credits) for expenses incurred by low-income older homeowners in correcting certified housing deficiencies.*

ISSUE 2: Should Congress support the use of specific technologies in the home that assist slightly impaired older persons in carrying out their daily activities?

Options:

2.1 *Congress could avoid further involvement in promoting or subsidizing specific home-based technologies or self-help devices for the elderly.*

2.2 *Congress could indirectly support the use of technologies in the home by encouraging or mandating that the Consumer Product Safety Commission (CPSC) monitor and evaluate the range of available products and self-help or assistive devices targeted toward elderly persons living at home. Such CPSC evaluation would discourage consumer fraud and indirectly provide consumer protection.*

2.3 *Congress could require specific safety standards on products used in the home to assist both the well elderly and those who are frail. These standards could be based on evaluations of product usefulness, safety, cost, and degree of complexity.*

2.4 *Relatively low-cost technologies that can be easily added in the home to promote safety, such as stair treads, grab bars, and other alterations, could be encouraged by Congress through amendments to housing rehabilitation programs and in coordination with social service programs under the Older Americans and Social Security Acts. Selected technologies could be specified for these purposes.*

2.5 *Congress could promote the use of more costly or complex technologies such as electronic devices (e.g., alarm systems), telecommunications, and similar devices for use in the homes of older persons. Such Federal support could involve consumer information programs, tax incentives, social service coordination, or direct cost subsidies.*

2.6 *Congress could limit Federal involvement by only subsidizing the use of selected assistive devices that are not now considered medically reimbursable under Medicare, such as hearing aids and corrective lenses. The Medicare reimbursement criteria would include medical evaluation and certification of need.*

ISSUE 3: How could Congress encourage utilization of technologies that promote the independence of older persons with functional impairments and major activity limitations?

Options:

3.1 *Congress could maintain existent housing and social service policies that generally favor those who are functionally independent.*

3.2 *Congress could require increased utilization of technologies for functionally impaired older people in federally subsidized housing through requirements under the Section 202 or Section 8 housing programs. Coordination with Title XX and OAA social service programs would also be necessary, as well as development of standardized functional assessment technologies.*

3.3 *Congress could expand the scope of such assistance to include similar utilization of in-home devices for all older persons who require assistive devices to maintain their independence in the community and the home (functional assessment technologies are assumed from option 3.2).*

3.4 *Congress could indirectly support efforts to increase the utilization of in-home assistive devices for the functionally impaired elderly through public information programs and the coordination or advocacy activities of social service agencies.*

ISSUE 4: Should Congress provide increased support for public and private sector efforts to develop and utilize new housing construction and design technologies that assist older persons to maintain their independence in the home?

Options:

4.1 *Congress could maintain its current level of support through existing Federal housing programs and incentives to the private sector.*

4.2 Congress could expand the scope of existing Federal housing rehabilitation loan programs (e.g., Section 312) or encourage the expansion of community-based grants (for low-income persons) through the CDBG program to promote the redesign and retrofitting of existing dwelling units. The programs could focus on structural changes that are required to permit older persons who have become functionally disabled to remain in their homes (e.g., design changes such as ramps, doorway openings, counter heights, etc., for those who become confined to wheelchairs).

4.3 Congress could promote similar redesign by developers of specialized housing complexes for impaired older people through tax incentives, Federal loan subsidies through HUD and FmHA programs, or other financing assistance.

ISSUE 5: Should Congress encourage and assist the expansion of housing alternatives that promote the continued functional independence, social wellbeing, or financial welfare of older persons?

Options:

5.1 Congress could encourage increased levels of funding for research and demonstrations that investigate the feasibility of various housing alternatives such as accessory units, granny flats, shared housing, board and care, and congregate housing. Cost-effective methods to develop such alternatives could also be investigated, including modular construction, conversion of commercial structures, and use of manufactured housing.

5.2 Congress could utilize existing information on the prevalence of single-family housing among older homeowners, especially low-income persons living alone, to support construction of accessory units as rental apartments. New construction and retrofitting technologies, such as factory-built modular bathroom and kitchen units, could be encouraged to control costs while expanding the housing stock for both older and younger persons.

5.3 Congress could earmark specific sums for funding the expansion of shared housing programs through coordinated efforts under Title XX, OAA, and HUD. Other support could be provided through programs such as Section 312 to subsidize necessary rehabilitation of existing houses to make them safe and sanitary for shared housing use. Such efforts could be linked with community-based development of long-term care programs to encourage informal supports along with formal services.

5.4 Congress could subsidize, through direct HUD and FmHA funding assistance and indirect tax incentives, private sector conversion of dormant commercial and industrial space into rental units. Special consideration could be given to those projects that are for central city and rural areas, that meet Federal design requirements for elderly/handicapped residents, and that encourage the provision of congregate services.

5.5 Federal assistance similar to that described in option 5.4 could be made available to promote board and care facilities that meet additional requirements for assisting functionally impaired (but not ill) older persons through long-term care and congregate services.

5.6 Congress could promote the development of various home equity conversion options (e.g., reverse mortgages, sale leasebacks) for older homeowners. Included in such legislation would be adequate consumer safeguards, protection of certain in-kind and entitlement benefits, federally-subsidized insurance for such financing, and Federal income tax incentives for private sector activity.

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Chapter 10

Workplace Technology and the Employment of Older Adults

Contents

Page

Introduction 335

Technology, Older Adults, and Employment Opportunities 336

  Technology and Job Opportunities 337

  The Future 341

Technology, Retraining, and Older Adults 349

  Benefits From Training and Retraining 350

  Costs of Training and Retraining 350

  Methods of Training and Retraining 351

  Factors Affecting Participation of Older Persons in Retraining Programs 352

  Case Study Examples of Retraining 353

  The Future 354

Technology, Health, and Physical Capacity 355

  The Future 356

  Priority Areas for Research 357

Issues and Options 358

Technical Memorandum A: Workplace Devices 359

Technical Memorandum B: Industries in Detail 363

Technical Memorandum C: Training Methods 364

Technical Memorandum D: Projected Job Growth Rates in High-Technology Industries 364

Chapter 10 References 365

Chapter 10

Workplace Technology and the Employment of Older Adults

Introduction

The structure of the American economy has undergone major changes since the mid-1800s. In 1850, the largest sector of the economy was farming, which employed 64 percent of the labor force. Each farm worker of that era produced enough food for four people. As the mechanization of farm work progressed, more food could be grown and harvested by fewer workers. Machines such as the cotton gin, tractor, plow, and reaper revolutionized productivity to the point that although only 3.1 percent of today's workers are farmers, each farmer provides enough food for 78 people (37).

By the 1900s the mechanization of farming had substantially lowered the prices of many products. Spinning and weaving machinery, for example, combined with the cotton gin to reduce cotton prices. The concomitant decline in need for farm labor pushed workers into urban areas, where factory employment was available. By 1920, two of every five jobs were in the manufacturing industry, and the share of farm employment had fallen to 11 percent (37).

Today, the concentration of jobs in the economy is shifting once again; manufacturing jobs are giving way to service sector employment. During the manufacturing boom of the 1920s, service employment accounted for only 11 percent of the work force. In the 1980s, the growing number of two-earner families has spurred interest in dining out, traveling, and a range of other support services for busy families. As a result, new jobs in the service sector abound, and the proportion of jobs in this sector rose from 11 percent in 1920 to 22 percent in 1982. At the same time, the emphasis on efforts required by occupations within these industries has shifted from physical to mental as machines take over many manual functions.

Today, workers 45 and over (hereinafter called "older workers") are largely located in the industries and occupations that offered good job prospects at the time they chose their careers. Older workers are concentrated in manufacturing industries, which, though declining during the 1950s, continued to hold the largest proportion of workers. Both service and trade were then expanding. The country was experiencing growth and workers expected bright futures.

The unprecedented, explosive pace of recent changes in workplace technologies may, however, be threatening future job security of older workers. Advanced production technologies, computers, and robotics were not available when today's older workers were training for careers. New computer and technology-dependent jobs are becoming an increasingly larger share of the total job pool. Thus, workers lacking in appropriate technical skills have a decreasing number of employment opportunities. To remain employed, some older workers may be forced into low-skilled, low-paying jobs. Others may receive extensive on-the-job training but may be forced to retire. Older workers who lose their jobs are likely to have difficulty finding new employment at previous pay levels.

Technology may also oust older workers from jobs in declining industries and occupations. New technology in these industries is making some jobs obsolete as machines substitute for human labor. The most rapidly declining industries are in manufacturing, and many of the declining occupations are in private household services and farming—all of which hold high proportions of older workers.

But just as technology threatens some older workers' chances of continuing in jobs they currently hold, it may be a boon for others. Technology is creating additional jobs in many of the other industries and occupations in which older workers are concentrated, and new service sector and clerical jobs may provide opportunities to some older workers. These growing industries and occupations may also signal opportunities for part-time work, which is a goal of many older workers. It is also a goal of women of all ages, whose number in the labor force is rapidly increasing and who may be a source of competition for these jobs.

Technology can be particularly helpful to older workers who have physical impairments, by offering them assistive devices to compensate for waning physical strength, eyesight, or hearing. Use of these devices can improve employment prospects for those not ready for retirement.

Technology can also benefit workers who are involved in physically hazardous jobs or who work with dangerous chemicals or materials. Machines are likely to replace many workers who once risked disease, disability, or death from years of exposure, freeing them to take less hazardous jobs.

As the requirements of many jobs change, continuous training and skill updating are becoming necessary components of work. Few opportunities for retraining of workers are available today, but it seems that older workers, for a variety of reasons, have even fewer training or retraining opportunities offered to them. This practice could change in the future, however, as the work force ages and as retraining becomes more common.

Technology can thus both help and hinder older workers' ability to continue working. If, on the one hand, current trends in innovation and implementation of mechanization continue, technology is likely to reduce opportunities for older workers or, at best, be neutral. On the other hand, technology has the potential to expand opportunities for older workers and to improve their working conditions. The future growth of workplace technologies and their impact on older workers are likely to require scrutiny by policymakers to improve the quality of worklife and provide job security for the total labor force.

Technology, older adults, and employment opportunities

Workplace technologies vary from simple tools and implements for individual workers to complex production systems that involve thousands of workers. The effects of technologies are equally varied—they eliminate old jobs and create new ones, enhance working conditions for some and act as barriers to employment for others.

Employment and the effects technology may have on an individual's work and work opportunities can be examined in relation to the economy's various segments: nine industrial sectors, each of which contains up to nine classes of occupations that in turn include various types of jobs. Technology can influence work in any or all of these categories.

Each of the potential effects of technology may, in turn, have an effect on workers over 40.[1] Little research has been conducted on the special problems faced by older workers as a result of new and changing technology, but the current state of technological change does not appear to be a major concern for older adults.

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[1] For purposes of this study, most of which is focused on workers over 45, older workers are defined as employees aged 40 and over, because this is the age: 1) at which protection from discriminatory hiring and firing practices begins under the Age Discrimination in Employment Act (ADEA) of 1978; 2) at which many workers begin to notice changing occupational opportunities; 3) designated in much of the research literature as older employees; and 4) of those aged 40 to 45 in 1980 who will be 60 to 65 in 2000, the period generally covered in this study.

Technology and job opportunities

LABOR FORCE PARTICIPATION TRENDS OF OLDER WORKERS

Patterns of labor force participation of workers 45 and over have been changing steadily since the early 1900s. For men, labor force participation has declined across all older age groups over time. Between 1940 and 1983, participation of men 45 to 54 fell from 96 to 91 percent, participation of men 55 to 64 dropped from 87 to 70 percent, and the proportion of men over 65 in the labor force declined dramatically from 45 to 17 percent.

Patterns for women have taken a different course. The composition of the labor force has changed to include far more women; 43 percent of today's U.S. workers are women. In 1940, 24 percent of women aged 45 to 54 worked outside the home; this figure rose to 62 percent in 1983. The participation of women aged 55 to 64 also increased—from 19 to 42 percent—while participation of those over 65 remained relatively steady at 7 percent in 1940 and 8 percent in 1983.

According to 1983 data, large numbers of men and women over 65 were in the labor force but overall participation rates obscure substantial variation among more detailed age groupings. Although participation for men over 65 was shown to be 17 percent, 25 percent of those 65 to 69 were working compared with 17 percent of those 70 to 74 and only 8 percent of those over 75. The pattern is similar for older women. Aggregate data show participation rates to be 8 percent; this consists of 15 percent for women 65 to 69, 8 percent for those 70 to 74, and 3 percent for women over 75. This age-based trend is similar within each racial group.

Although participation *rates* of workers over 45 have fallen since early in the century, the *numbers* of those working have increased. In 1950, approximately 22 million workers were over 45; by 1983 the number of workers in this age group totaled almost 32 million. The 55-to-64 age group reached 12 million in 1983 (up from 8 million in 1950) and there were 3 million workers over 65 in both 1950 and 1983. These increases in numbers have occurred *despite* drops in participation rates.

Several factors are said to account for the decline in proportions of older workers. Some companies relieve the excess in their labor forces by offering incentives to older workers to retire early. Poor health has also been a limiting factor in work participation, as discussed later in this chapter. In addition, some legislation has supplied incentives to leave the labor force by age 65 or before. The availability of Social Security and private pensions often makes it financially feasible for workers to retire before 65.

Though the labor force participation rates of older men are expected to continue declining, current and proposed legislation that influences the choice to retire or remain employed does not encourage early retirement. Recent amendments to the Social Security Act raised the start-up age for collecting full retirement benefits from 65 to 67, which will be phased in between 2000 and 2022. The 1978 amendments to the Age Discrimination in Employment Act (ADEA) raised the age at which employees can be forcibly retired from 65 to 70. Recommendations to streamline the Medicare system have proposed raising the age of eligibility from 65 to 67 to encourage people to continue working in order to be covered by insurance plans.

INDUSTRY TRENDS

Since 1900, changing technology, coupled with shifts in consumer demand, has redistributed the concentration of jobs among industries. In 1900, 36 percent of jobs were in manufacturing, 16 percent in trade, and 11 percent in services; today only 20 percent of jobs are in manufacturing while the trade and service industries each account for 22 percent. Between 1969 and 1979, almost 90 percent of gains in total employment occurred in the service-producing sector.

These sectors—manufacturing, service, and trade—are those in which workers over 45 are most likely to be employed. Men between 45 and 64 are most likely to be involved in manufactur-

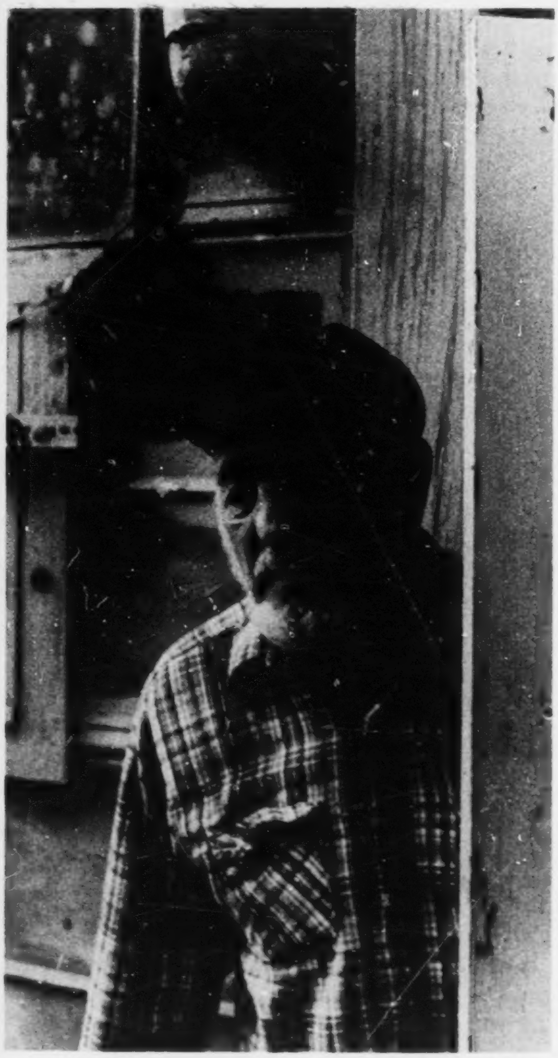

Photo credit: Alonzo Zamorra

Some older workers are employed in trade or service occupations that have not been affected by technological change.

ing; men over 65 are most often employed in services; and women over 45 are most likely to have jobs in the service sector.

OCCUPATIONAL TRENDS

Major economic shifts can be seen in growth comparisons of white-collar, blue-collar, and service workers over time. In 1940, workers employed in these occupations accounted for 31, 57, and 12 percent of the labor force respectively. By 1980, these percentages had shifted to 54 percent, 34 percent, and 12 percent (13). This increase in both numbers and proportion of white-collar workers indicates that jobs are becoming less physically demanding and require more intellectual skills.

The potential effects of changing technology on older workers are seen in comparisons of occupational trends by age. Among male workers 45 to 64, the greatest number (21 percent) are in crafts, followed by managerial workers (19 percent), and professional/technical occupations (17 percent). The highest percentages of men over 65 are in management (18 percent, or 2 percent of all management workers), the next highest in professional/technical (15 percent, or 2 percent of all professional/technical workers), and service (13 percent, or 2 percent of all service workers) occupations.

The pattern for female workers is again very different. Employed women 45 to 64 are concentrated in clerical jobs; 40 percent of all working women 45 to 64 are clerical workers. Lower proportions are involved in service (21 percent) or professional/technical (19 percent) work. Women over 65 are most often found in clerical (25 percent, or 2 percent of all clerical workers) or service (21 percent, or 2 percent of all service workers) occupations; 10 percent of all private household workers are women over 65.

Regardless of the number of older workers across occupations, certain occupations, particularly farm, private household, and managerial occupations, have higher concentrations of older workers. Half of all farmers and farm laborers are men over 45 (14 percent are men over 65). Thirty percent of managers and administrators are men over 45. Among private household workers, 2 of every 5 are women over 45 (1 in 10 is over 65) and 1 in 5 of those employed in a clerical occupation is a woman over 45.

Large proportions of today's older workers are being affected by new technology as it rapidly changes the ways in which work is done. But little is specifically known about the extent of the influence of technology, or whether older or younger workers are more influenced by it. It is clear, however, that workers of all ages will need to adapt to changing needs for skills.

Several examples illustrate this point. The nature of clerical jobs is undergoing significant change. Many offices are switching from electric typewriters, which process one page at a time, to computers and word processors that can edit, store, and print lengthy documents in seconds or minutes. The quality and speed of these document printers has increased from a printwheel printtime of 2 minutes per page to laser printers that produce typeset quality print in only 4 seconds per page. Executives of the future can expect to dictate directly into a sophisticated computer that understands spoken language and can type the document simultaneously as it is dictated. There may thus be fewer clerical workers needed in the future, and secretaries may need word processing, editing, and proofreading skills rather than typing skills.

Service jobs are also changing. For example, telephone operators' jobs are changing as companies install computerized switching equipment. Computers take incoming calls and distribute them to available operators. In some locations, though the human operator may take requests for specific phone numbers, the numbers are spoken to the requester by a computer-synthesized voice while the operator takes the next call.

Computers will make the jobs of some managers easier and may, in some companies, eliminate some middle-management positions. Computers allow greater and faster corporate access to information and the ability to monitor the work being performed by staff. In addition, experts believe that computers can widen the span of control of middle management so that fewer managers will be needed to supervise the same number of employees (5).

Computers may also simplify such professional/technical jobs as those of scientists. Quick access to data bases and the use of special software packages that perform difficult and time-consuming calculations and create special graphics are among some of the improvements. Architects can now rely on computer-generated renderings for some types of layouts, dramatically reducing the time required to produce the final blueprints.

Eventually, the jobs of many private household workers who are over 45 are likely to be directly affected by robots that can perform housekeeping chores. Some high-cost robots now available can be programmed to do such jobs as window-washing, floor-mopping, and vacuuming. Human workers may provide supervision and maintenance to these mechanical helpers.

Although technological change may reduce job opportunities for some older workers as new technologies continue to emerge, other older workers will be able to compete with younger workers for jobs that require new combinations of skills.

JOB TRENDS

In specific industries or occupations technological advances will both change the way people do their jobs and greatly reduce the number of jobs. When jobs are eliminated, the workers who held them are said to be displaced, i.e., unable to find the same type of work again.

Despite the absence of comprehensive data, it is clear that technology, as well as other factors, has displaced some laborers, service station attendants, stenographers, and workers in printing, agriculture, longshoring, communications, mining, and textiles (1,24,37,38,39,45). Several hundred thousand metalworking positions and thousands of white-collar jobs are estimated to have been lost due to technological innovation over an extended period of time (8). For example, the crafts occupations—which include printing and some metalworking occupations—employ a large percentage of older workers. Because roughly one-third of workers in white-collar jobs are over 45, and the percentage of these jobs is expected to decline slightly through 1995, older workers in these occupations are also at risk of losing employment.

A small degree of displacement among older workers has been documented, but the data on displacement do not distinguish between technological change and other causes of job loss. A longitudinal survey begun in 1966 found that 7 percent of men over 45 in a national sample had suffered an involuntary job loss over a 10-year period. Occupation, age, and education had little

Photo credit: Alonzo Zamorra

Technological advances are displacing some service station workers.

effect on the probability of older worker displacement. Displacement occurred more frequently in the private than in the public sector and less frequently in companies with pension benefits. Displacement rates were, however, higher in the manufacturing and trade industries, where older workers are most heavily concentrated (31).

The impact of technological change on currently employed workers is unclear. Many labor union officials contend that the use of robotics and other technological innovations will displace workers. Some industry officials estimate that computer-integrated manufacturing systems reduce labor requirements by between 3 to 1 and 20 to 1 (48). Manufacturers and users of these machines argue that any employment impacts will be considerably reduced by attrition, retirement, and retraining of existing workers (45,50). Observers in the automobile industry argue that although technological innovations such as robots may cause immediate displacements, they will ultimately create more jobs by making the United States more competitive with foreign producers (8). Technological advances are also expected to create totally new areas of work.

Unemployment is a common consequence of displacement. Although one-third to one-half of those who lost jobs moved to new employment almost immediately, an additional one-third were unemployed up to 13 weeks, and the rest were unemployed longer than 13 weeks. The period of unemployment, however, was contingent on the economic conditions at the time of displacement. As might be expected, those unemployed in an unfavorable job market had longer periods of idleness than did workers displaced during better economic times. The state of the economy is thus likely to be very important to an older person's ability to keep or get work.

A 1980 report found unemployment significantly related to the decision to retire early; that "older male workers are being forced out of the work force by a variety of factors such as age discrimination, and technological obsolescence . . . Retirement legitimizes withdrawal from the work force in the face of difficulties finding suitable work" (6). Even when such factors as health, socioeconomic status, available income, etc., were taken into account, unemployment was associated with early retirement. The study also found that for white workers, 1 week of unemployment encouraged workers to retire to the same extent that $1,000 in savings, stocks, and bonds would affect this decision.

One of the most striking effects of displacement and unemployment is the reported reduction in wages upon reemployment. The Parnes longitudinal study found that the major lasting effect of displacement was lower wages; those who had been displaced experienced average earnings that were 22 percent below those workers who had not been displaced (31). A study of the automobile and steel industries found that when displaced workers became reemployed, they did so at lower earnings than they had previously enjoyed. The authors estimate that displacement resulted in a permanent earnings loss ranging from 7 to 15 percent of annual income (20). Another study of displaced workers found hourly wages averaged 33 percent lower at reemployment (46).

Job tenure, which is strongly associated with age, also influences wages at reemployment. The longer the tenure, the greater the relative loss in earnings upon reemployment (20). The Congressional Budget Office estimated that displaced workers with fewer than 10 years seniority were, after 2 to 6 years, earning 91 percent of what they would have earned had they not been displaced. Workers with 10 to 20 or more years of service had wages 81 and 75 percent, respectively, of what they would otherwise have earned. Some experts estimate that $50 for every year over age 25 is lost at reemployment after displacement (14).

Older workers also experience longer periods of unemployment than do younger workers (in 1981 the mean duration of unemployment was 14.8 weeks for workers 25 to 54, 18.3 weeks for workers 55 to 64, and 16.0 weeks for workers over 65). This long period of unemployment may result in discouragement, feelings of futility, and eventual discontinuation of efforts to find new employment. Data from the Bureau of Labor Statistics reveal the magnitude of the increase in unemployment rates when discouraged workers are included. The 1968-81 period showed an average increase from the adjustment of 0.5 percent for men and 1.2 percent for women in the 25 to 54 group; 0.5 percent for men and 1.5 percent for women in the 55 to 64 group; and 3.2 percent for men and 4.7 percent for women in the over-65 group. As a result of their discouragement, some older adults who have been displaced from their jobs may choose to retire.

Both displacement and unemployment can affect retirement income. If displacement occurs before one is fully vested in a pension, pension income can be completely lost. Furthermore, since Social Security benefits are calculated on the basis of earnings, lower wages at reemployment can lead to lower Social Security income following retirement.

The future

THE PROJECTIONS

Estimates of the size of the future labor force and levels of industrial and occupational employment are based on varying sets of official government projections. The most frequently used projections are those developed by the Department of Labor's Bureau of Labor Statistics (BLS). Industry, occupation, and labor force projections are available to 1995, although they are generally acknowledged to be reasonably accurate for no more than 5 or, at most, 10 years. High, middle, and low projections reflect varying assumptions about fertility, mortality, migration, and individual socioeconomic characteristics. Occupations that are likely to be affected by automation are identified, but the BLS does not project the impact of automation on employment levels by occupation or determine the number of individuals likely to be displaced by technology.

Though projections of future employment (including labor force, gross national product, employment by industry, and employment by occupation) are invaluable for public planning and private decisionmaking, they depend on accurate anticipation of changes in the economy. Since it is impossible to correctly predict what may occur 10 years hence, three alternative sets of assumptions are developed in order to establish a range of possible outcomes.

Because the art of projection is predicated on the use of numerous assumptions, different combinations of assumptions can produce wide variations in outcomes. Four BLS projections of the 1980 labor force, made between 1965 and 1976, were below actual totals. Much of this discrepancy was due to difficulties in predicting the activities of specific groups. For example, projections of male participation rates were overestimated while female participation rates were greatly underestimated. The participation rate for women 25 to 34 in 1980 was a full 25 percent higher than projected in 1965. For women 35 to 44, projection underestimation errors ranged from 15.2

percent in 1965 to 7.2 percent in 1976. Another problematic projection was for men 55 to 64; the 1965 projections overshot their actual participation rate by 12.3 percent. The 1976 projections were off by only 1.1 percent.

Data Resources, Inc. (DRI), also forecasts civilian labor force participation. Although BLS projections were, on the whole, more accurate (mean absolute deviation between actual and projected figures was 2.0 for BLS v. 2.5 for DRI), the DRI projections were closer to actual participation rates for females, particularly those in the problematic age category of 25 to 34. DRI's least accurate projections, those for women 35 to 44, were still closer than those made by the BLS. Though projections by both organizations can be inaccurate, the BLS projections are used in this report in order to be consistent with Federal usage of these data for policymaking.

Projections of industry and occupation are unavailable by age, largely because of the difficulty of predicting individual job choices, which are based on numerous past experiences, future expectations, and personal decisions. There are thus no projections on which to base estimates of the influence of future industrial and occupational shifts on labor force participation of older workers. Yet certain possible effects can be anticipated, given what is already known about technological change and jobs held by current older workers.

LABOR FORCE PROJECTIONS

Current BLS middle-growth projections indicate that the size of the labor force will increase from 102 million in 1982 to 127 million in 1995. Most of this increase is expected to occur between 1982 and 1990 as the U.S. economy recovers from the recent recession. Between 1990 and 1995, employment is expected to climb, but at a slower rate (34).

Three general trends are projected (12):

- Over the next several years labor force participation rates for women 20 to 44 are expected to continue their recent upward spiral, after which they will return to a slower growth rate than that of the 1970s.
- Labor force participation rates for men over 55 are expected to continue declining, although at a slower rate than during the 1970s.
- Labor force participation rates for men 20 to 44 are expected to continue declining, also at a slower pace than during the 1970s.

The projected labor force for 1995 shows a continuing high percentage of workers under 45 and an increasingly smaller proportion of workers over 55. The group between 45 and 54 in 1995, which includes part of the baby boom cohort, is expected to grow by 4 percentage points, or 10 million workers, from its 1982 total. Middle-growth projections to 1995 suggest a slight growth in numbers of older workers in some age subgroups and a decline in others. In a total labor force of just over 131 million, workers over 45 would account for 30 percent of the labor force (39 million). Of this group, 11 million (8 percent of the labor force) would be 55 to 64 and 3 million (just over 2 percent of the labor force) would be over 65.

The growth in number and proportion of older workers will mean an eventual maturing of the labor force. The labor force reached its highest median age, almost 41 years, about 1960. The recent influx of baby boom workers has sharply decreased the median age to a low of 35 years in 1982. The median age will continue at about this level until 1995, when all the cohorts of baby boom workers will be over 35, boosting the median age to well over 37 years. This maturing of the labor force may enable industry to enjoy higher productivity and lower unemployment over the next 12 years as the individuals who make up the labor force become better educated, have a wider range of needed skills, and gain additional seniority (12).

The direction of future changes in labor force participation of older workers differs markedly by sex, but not by race. The labor force participation rates of men of all races over 45 are expected either to remain constant to 1995 or to decline, in some cases substantially. For instance, participation of white men 55 to 64 is expected to drop from 70 percent in 1983 to 66 percent in 1995; among those over 65 it is expected to drop from 19 to 14 percent. Black men are expected to show similar patterns.

The proportion of women job holders over 45 in 1995 is expected to increase from 1983 levels. Participation rates for both white and black women 45 to 54 are expected to increase dramatically; a moderate increase is projected for women of both races aged 55 to 64. The participation of women over 65, however, is expected to decrease slightly.

INDUSTRY PROJECTIONS

BLS projections assume that "smokestack industries" will not vanish, and attribute their recent job losses to the economy. Yet manufacturing is expected to grow slightly, accounting for only one of every six new jobs between 1982 and 1995. In key manufacturing industries such as automobiles and steel, previous employment peaks are not expected to be regained.[4] Increasing consumer demand will boost production, but productivity gains through advanced technology and management efficiencies are likely to limit employment expansion (34).

Most of the new jobs—an estimated 75 percent of those added through 1995—will be in the service sector. Within this broadly defined sector, medical care, business services, hotels, personal services, and nonprofit organizations are expected to account for one out of every three new jobs.

Employment patterns in other industries are also expected to change. The trade industry is expected to show large growth while both construction and finance/insurance/real estate are projected to grow moderately. The remaining industries should gain only slightly in employment, with the exception of agriculture, which is expected to decline slightly.

Assuming that the current industrial distribution of cohorts of workers now 45 to 54 and 55 to 64 remains the same in the future, and that labor force growth follows BLS projections, these workers are likely to be employed in industries with high or moderate growth rates. Manufacturing, which has the greatest concentration of workers over 45, is likely to grow moderately, while services and trade are expected to grow very quickly. This growth in demand for labor could produce more job opportunities for older workers, unless younger workers and mechanization limit these opportunities. Furthermore, since service jobs engage a high proportion of other than full-time workers, and older adults report a desire to do part-time work, the high-growth service sector may play an increasing role in the employment of older workers.

The size of the employing firm has an important effect on the status of older workers. In 1979 about 72 percent of workers over 65 worked in firms employing fewer than 100 people; 39 percent of those 55 to 64 did so. This is particularly significant since about 78 percent of the employment growth in the private sector between 1978 and 1980 occurred in businesses with fewer than 100 employees (this figure does not represent the volatility of these businesses, which often fail within 3 years). The explosion of employment in these small businesses may provide new jobs for older employees who wish to continue working. These firms may be more flexible as to work structure, allowing alternative options to full-time work for employees. Older people are seeking and finding employment in these small establishments. Of those workers over 65 in wholesale and retail trades and the finance/insurance/real estate sectors, the vast majority work in firms with 25 or fewer employees.

OCCUPATION PROJECTIONS

Though demand for products is expected to provide greater impetus for employment shifts than labor-saving technology, automation is likely to change the distribution of occupations. The 1995 forecast for specific occupations shows that the largest redistributional effects will be among professional/technical workers, who are expected to gain just under 1 percent of jobs, and farmers/farm workers, who are expected to lose the same proportion. Operative employment and laborers are also likely to show an overall loss, and managers, craft, and service workers an overall gain. Some specific occupations are likely to decline. By 1995, the proportion of white-collar workers is expected to be 52 percent—close to today's level. Blue-collar workers are expected to decline from 34 percent in 1980 to 29 percent in 1995 and service occupations to increase slightly from 12 percent in 1980 to 16 percent in 1995 (42).

Projections of the influence of high technology on job growth depend on which BLS definition is used. Under the broadest definition of "high-technology" industries,[2] technology-related employment could account for 17 percent of all new jobs between 1982 and 1995; under the most limited definition it would account for only 3 percent of these jobs (for specific growth expectations see technical memorandum D) (42).

The *percentage* growth of specific occupations within these fast-growing industries is particularly high in occupations dealing directly with new technologies. In middle-growth projections to 1995, most of the 20 fastest growing occupations center around computer programming, servicing, operating, and repair. Growth rates will also be high for electrical and mechanical engineers, physical and occupational therapists, and medical and banking clerks.

Growth in the *number* of jobs by 1995 affects a different set of occupations. According to BLS projections, only 40 of the existing 1,700 occupations will account for 50 percent of all employment growth. The greatest number of new jobs will be available to building custodians, followed closely by cashiers, secretaries, office and sales clerks, nurses, and waiters and waitresses. Some of these job categories are largely independent of new technologies and they are unlikely to be affected by technological change. A few, such as office work and nursing, may be notably affected. Most, however, are relatively low-wage manufacturing and service sector jobs.

A number of occupations are projected to undergo rapid decline between 1982 and 1995, as a result of expected demographic and economic changes in the United States. Heading the list for declines are jobs related to transportation, such as railroad conductors and taxi drivers, probably due to declining demand for these modes of transportation. Numbers of private household workers and servants, child-care workers, college and university faculty, and graduate assistants are likely to decline due to the lower numbers of young people. Among the many occupations being threatened by technology are postal clerks, postmasters and mail superintendents, stenographers, typesetters and compositors, and rotary drill operators. If occupational employment patterns for current cohorts of workers 45 to 54 and 55 to 64 were to remain constant, future older workers would be unlikely to benefit from the projected new and additional jobs in high-technology fields. Most older adults are located in slow-growing professional, managerial, or craft occupations, and only small proportions of workers over 45 are currently employed in occupations such as scientists, computer programmers, or computer technicians. They are consequently less likely than younger workers to have the unique education and training necessary to compete for or to keep these jobs.

Older workers may, however, benefit from growth in the number of jobs in manufacturing and service sectors, which contain large numbers of older workers, and clerical or service occupations, where older workers are also concentrated. Other workers may see their job opportunities decline. The kinds of occupations that are likely to diminish in number are precisely those farm, professional, and specific craft occupations in which older workers tend to be employed.

Robotics are a major source of the controversy surrounding displacement of future workers. Some experts contend that industrial robots may increase from today's estimated 3,000 to as many as 25,000 in the automobile industry alone by 1990, and these may eliminate a large number of jobs (8,18). According to General Motors, a robot displaces 1.7 workers in an assembly plant and 2.7 workers in a manufacturing plant (27). A recent study by the American Society of Manufac-

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[2] The BLS provides three definitions of high technology, ranging from very broad to very limited. They are, in order of magnitude from broad to limited, the following: 1) Any industry that utilizes technology-oriented workers accounting for a proportion of total employment of at least 1½ times the average for all industries. A total of 48 industries are included in this category, three-quarters of them in manufacturing. 2) The proportion of technology-oriented workers relative to total employment in the industry is equal to or greater than the average for all manufacturing industries and the ratio of R&D expenditures to sales is close to or above the average for all industries. This group includes 28 industries, and excludes most nonmanufacturing industries. 3) The ratio of R&D expenditures to net sales is at least twice the average for all industries. This definition includes only six industries, all in manufacturing.

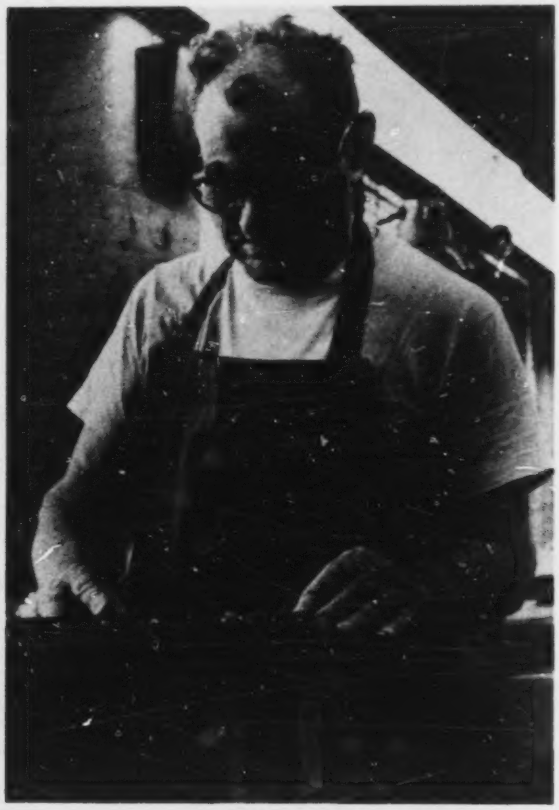

Photo credit: The Coach Leatherware Co., Inc.

Job opportunities for skilled craft workers are expected to decline in the future.

turing Engineers predicted that as many as 20 percent of existing jobs in the automobile industry could be performed by robots by 1985 (25). The large numbers of older people who are automobile workers or who work in other manufacturing and craft occupations may thus be at great risk of being displaced, although the need for robot maintenance and repair will create new jobs for some of these individuals.

Robotics may threaten jobs in areas other than automobile and steel manufacturing. Based on a survey of users and manufacturers of robots, Robotics International predicts that 3 percent of current packers and wrappers, 5 percent of welders and flamecutters, and 10 percent of production painters would lose their jobs (35). Similarly, a study of the Michigan auto industry finds that between 10,500 and 18,000 jobs, primarily welding and production paint jobs, are destined to be eliminated over the next 10 years by technology. A Carnegie-Mellon study has identified 4 million factory jobs that robots will perform, and an additional 3 million jobs that robots might assume by the year 2000 (7).

The lack of specific information on older workers makes it difficult to determine which future older employees will be at risk of job loss due to technological change. Nonetheless, information about displaced workers in the Parnes longitudinal survey provides the basis for possible future scenarios. In that study, displaced older workers were most likely to be employed in the trade and manufacturing industries. Because projections indicate that employment in both of these industries will grow, the future could provide many employment opportunities for older workers, either to remain in the labor force or to change jobs. If many of these new jobs are technologically oriented, however, some older workers may need training. For example, growth in manufacturing jobs is likely to be at either the high or low end of the skill and wage continuum: either low-paying occupations such as office clerks or custodians, or high-paying, high-skill occupations such as computer technicians. Most older workers need training to work in the higher end of the skill and pay scales because they are less likely to hold these kinds of jobs today. Without training, older workers may have an increasing number of jobs available to them but the jobs will be at lower wages and at lower skill levels.

Yet current displacement rates in these industries are high. In 1982, 51 percent of all layoffs and 28 percent of permanent job separations occurred in the manufacturing industry. Trade ranked a close second in separations, followed by services. If older workers continue to be displaced in these industries, the growth in these industries could result in net job losses for older workers.

Occupations with high concentrations of older workers also had a high mean displacement rate in the Parnes study. Service, professional/managerial, and craft workers experienced involuntary job loss more often than other groups. Future employment in these occupational groups is likely to grow, although at varying rates. If technological change does not radically alter specific jobs within these groups and older workers remain concentrated in the same industries, they may be at low risk of future displacement.

There is as yet little agreement on the overall number of workers who face displacement by technology. There is some consensus that technology will reduce the number of future jobs available in some occupations, but its effects on currently employed workers remain difficult to predict.

NATURE OF WORK

Replacement of workers with machines or robots may also change the nature of work itself by changing the number of hours people spend at work, the type of work done, the skills needed, and the sites at which work is performed.

At the turn of the century, workers often worked 14 hours a day, 7 days a week, 52 weeks a year. Today's standard 40-hour, 5-day workweek can be partially attributed to the mechanization of industry that increased the productivity of workers. Workweeks have been shortened even further in companies that have raised the number of hours worked per day while keeping constant the number of hours worked per week (40-hour, 4-day weeks with 10-hour days). Other companies have reduced both total hours and days worked per week (36-hour, 3-day weeks with 12-hour days). The BLS forecasts that the length of factory workweeks will be virtually unchanged in 1995 at 38.8 hours, compared with 38.9 hours today. For the private, nonfarm economy, average weekly hours are projected to fall from 35.1 in 1982 to 33.1 in 1995.

Future technology will also change the type of work and the skills needed in some jobs. For example, "paperless offices" of the future will hold all records and files in a central computer, eliminating the need for an employee to move between typewriter and copying machine. Conveyor belts to move bulky material between offices may become commonplace. Clerical workers will need word processing skills or skills in computer programming and operation.

Libraries are undergoing rapid change. Time-consuming information searches that once sent librarians to card catalogs and bookstacks can now be done far more quickly and with minimal movement from behind a desk-top computer terminal.

Bank tellers may change from serving customers directly to servicing automatic tellers, with machines taking over mathematical calculations and recordkeeping while the human worker oversees their operation and replenishes supplies of money and paper.

In broader terms, managers may do more of their "managing" through computer monitoring of employees' work, increasing the number of people and amount of information managed by simplifying access to workers and their output. Decisionmaking itself is now entering the realm of the computer, which has already reduced the number of middle managers in some companies (23).

Technology can also change the nature of work by changing the requirements that work be done in specific locations. Typing or word processing that used to require secretaries to be at the workplace during working hours can now be done at home by using telephone-computer linkages. Hard copy could always be taken home for editing, or dictation typed directly into a computer and transmitted for print at an office work station. One corporate official estimates that the numbers of office workers who use some sort of electronic office equipment will rise from today's 5 million to 35 million within 10 years (7).

Advancing computer technology also allows work to be done while traveling, and communications technology, by the process known as "teleconferencing," can "assemble" meetings of people in far-flung locations without their having to leave home or office.

POSSIBLE IMPACT ON OLDER WORKERS

This evolution in job requirements may be particularly beneficial to older workers by allowing wider use of alternatives to full-time work. Results of some surveys show that part-time work or other alternatives to full-time employment are favored by many older workers. In 1979, about 26 percent of married and 21 percent of unmarried adults aged 65 to 69 worked part-time. A 1981 Harris poll found that 57 percent of respondents

A New Industry: Machines That See

Machines that "see" may change the jobs of some workers of the future. By combining a television camera and a computer (an "eye" and a "brain"), robot machines can be made to do many tasks that humans now do. Robots can handle tedious or dangerous jobs repeatedly and steadily without fatigue.

For example, a Westinghouse factory in Winston-Salem, NC, plans to use sighted robots to forge turbine blades. These robots select pieces of metal, place them in a furnace, then remove the hot metal and place it in a machine that shapes it into a blade. When the blade is finished, a robotic "eye" inspects it to be sure it is perfectly formed.

Other robots, which have arms, hands, and fingers, can select electronic components from bins and place them into circuit boards with greater speed and accuracy than humans.

The computer microchips that control these machines currently cost less than $10 each, which makes these robots and their capabilities attractive to employers. The systems themselves, however, are expensive—a complete vision system with only limited capacity often costs between $15,000 and $40,000.

Expanded use of these systems is expected to double or triple industry revenues from machine vision systems ($20 million in 1982) each year for the next several years.

Workerless Factories

Conventional "fixed automation systems" in factories are slowly being replaced by "flexible manufacturing systems." In a fixed system, machines are programmed to operate in a predefined sequence of steps to make a product; flexible systems alter their programs and hence their products, depending on such factors as the availability of materials, the speed of other machines making needed components, and the demand.

This new technology can increase productivity while employing fewer workers. For example, a system installed in a GE locomotive factory now produces a 2,500-pound motor frame—a job that once took 16 days—in 16 hours. While some workers were displaced by the new system, others have been retrained to monitor and control the computerized machinery. The floor foreman is now the console operator.

Flexible manufacturing enables some factories to operate with very few workers. A Japanese toolmaker factory in Florence, KY, which would need 240 workers with a conventional manufacturing system, now employs three shifts of 15 day-shift workers, four controllers in an evening shift, and no workers at night.

Improved quality and lower capital equipment and operating costs are other benefits of flexible manufacturing. A new system at Hughes Aircraft Co. cost 25 percent less to install than a conventional system and costs 87 percent less to operate (22).

The benefits or drawbacks for older workers of this developing technology are unclear. Devices for use in the work force could be designed to simplify jobs for workers with vision deficits or flagging muscle strength. At the same time, technology could eliminate many manufacturing jobs that currently employ large proportions of older adults (21).

Laser Cash Registers

The laser cash register has revolutionized the jobs of many grocery store clerks. They no longer need to read the price of each item before entering it into an adding machine, but can simply brush the item over a laser reader that reads the bar code now printed on most products. A computer interprets the bar code and assigns a price to the item. The clerks seldom need to know price information since it is all held in a central computer. Price changes can be accomplished by the push of a few buttons.

This equipment has several advantages, both to grocery store management and the customer. Management can access store inventory lists quickly by computer, adding new merchandise and subtracting goods sold with equal speed, while reducing need for inventory and stock clerks. The customer benefits in that lower payroll costs are likely to be reflected in lower food prices and individual items and unit costs are automatically itemized on purchase receipts.

would consider part-time work after retirement (17). A 1980 Traveler's Insurance Co. survey reported that 85 percent of their employees wanted paid work after retirement; over half preferred part-time work (44). Although these surveys have limited utility due to: 1) the gap between what people report they would do and their actual behavior; and 2) the lack of information about the specific circumstances in which people would accept a job offer, i.e., commuting time, wages, type of work, and working hours, the data indicate that *some* people would both prefer and use these options, and that developing these alternatives in the work force would be beneficial to them.

Although these alternative work options are as yet rare, a study by the National Commission on Employment Policy suggests that employers will expand employment opportunities for older workers as their numbers increase. Initial programs are likely to be developed because they benefit both employer and employee (32,40).

Some employers have tailored a variety of employment options to the needs of middle-aged and older employees, including active job recruitment of older people, job-sharing, labor pools for part-time work, and phased retirement. Older workers seldom take advantage of these options for two reasons: managers do not adequately communicate their existence, and taking advantage of these options may result in reduced salary and benefits. Company use of such options depends on such factors as: 1) the desire of the company to project a positive image of older workers, 2) the character of labor-management relations, 3) the need to meet productivity and labor demand, and 4) the condition of the economy. Fewer options are offered by companies in poor financial positions (32,40).

Some employers consider work options as employee benefits. Employment opportunities and new work options for older workers may be provided in order to attract older consumers, stabilize the younger work force with older role models, reduce absenteeism, gain experience in working with a generally older work force in anticipation of demographic changes, hire workers who will accept lower wages, encourage workers to stay at work to keep needed skills in their work forces, and respond to government policy (32,40).

Researchers who tapped the National Older Worker Information System at The University of Michigan (40) found data on 153 companies representing 309 programs and/or practices. These programs included six types: hiring for full-time employment (12 percent), hiring for part-time or temporary employment (51 percent), job/worker appraisal (5 percent), training (13 percent), job redesign (9 percent), and flexible scheduling (10 percent). On a national scale, few companies offer such options, but they are expected to become more plentiful as the number of older workers increases.

An important conclusion of these studies is that employers will provide options for older workers in the future, but only when it is to the firm's advantage to do so. As the older work force grows and seeks these options from employers, their range and number are likely to grow, particularly as new technologies make it easier for employers to accommodate to shifts in workdays, hours, and the daily work force.

Older workers are especially likely to benefit from the changing nature of work. People who find it physically difficult or undesirable to leave home, due to disability or poor health, may be able to work at home doing clerical and office tasks, for example, or computer programming, writing, or research. Should bad weather, a long commute, or inability to drive or difficulty in using public transportation keep potential workers at home, such jobs could be ideal.

Some technological changes may enhance such alternative work options as job-sharing. Workers using computers could store their work for use by a subsequent employee. By pairing an older worker with a younger worker, flexible scheduling could be beneficial for both workers. An older employee wanting to phase into retirement could train an upcoming employee to take his place, retaining needed skills for the employer.

Additional benefits of alternative work options include maintaining more people in the work force than would be possible if each worker had a full-time job, providing additional income tax and Social Security tax revenues, delaying collection by retirees of Social Security or pension benefits, and providing a higher income for older adults.

As these options become more common, competition for them is likely to increase between older and younger workers, especially women, who are currently seeking new work structures in order to accommodate pressing financial and family obligations.

Technology, retraining, and older adults

Retraining workers of every age is a matter for serious consideration by both industry and government. Some employers are expressing concern that the available pool of labor will not satisfy their needs for skills. In the quest to keep worker skills current, some older workers may need particular attention (33).

Information is meager about the extent of need for retraining older workers. Among the important questions are: 1) how well do older workers' skills match the skills needed in the labor market? 2) how quickly are older worker's skills becoming obsolete? 3) if older workers are retrained, how long will their skills be of value to the employer? 4) how are older workers differentially affected by employer policies for retraining due to advancing technology? 5) what effect does technology have on the working environment? and 6) will older workers, if retrained, be able to compete successfully with younger workers for jobs?

The need to update workers' skills will increase in importance as technology continues to change. As the labor force ages, fewer younger people with recently learned skills will be available; in turning to other sources for skills, employers will need to focus on existing workers.

Jobs and the skills needed to do them are changing rapidly. Change may occur so quickly in the future that, according to one expert, in order to maintain their skills, workers may need to be retrained from five to eight times over the course of their careers (7).

Employers and their unions are beginning to recognize the growing need for new skills. In the spring of 1982 the United Auto Workers Union gained commitments from General Motors and Ford Motor Co. for $20 million and $25 million, respectively, to begin retraining programs for their workers. Is the access of older workers to these training programs comparable to that of younger workers? Will large numbers of older workers be retrained? Sources within the training industry indicate that older workers have fewer opportunities than younger employees to be retrained at employer expense. This unwritten standard concerning retraining may stem from a wide variety of causes—negative attitudes about older age, age discrimination, the belief that older workers will not want or be able to be retrained, or the belief that older workers will, by retiring in a few years, be relatively more expensive to retrain than younger workers.

Some efforts are being made to retrain existing workers. Employers are retraining both currently employed and displaced or unemployed workers to ensure their supply of skilled labor. Although no figures are available on how much is spent specifically on retraining or which employees receive it, the American Society for Training and Development estimates that employers spend about $30 billion a year for all types of employee retraining (9).

There is no comprehensive information available on the types of jobs targeted for retraining, but a review of business and training publications suggests much employer-sponsored retraining of existing employees is for engineering and other scientific positions, clerical workers, and specialized technicians. For example, machine mechanics are retrained to repair robots; engineers are updated on computer applications and electronics; clerical workers learn to use word processing and other computer equipment; chemical process engineers receive additional training in biological processes; and copier-repair technicians learn to service high-speed printers.

Though identifying workers displaced by technology is difficult, when displacement does occur, many workers become eligible either for jobs requiring similar skills or for retraining. Robotics International concluded that 50 percent of workers displaced by robots could be trained for new jobs in the same plant and another 25 percent could do other jobs in the plant without special training (35). Some unemployed workers, such as auto workers, are being retrained for jobs in robot repair and maintenance, electronics, and microelectronics.

Many observers agree that the need for retraining will accelerate as technological change affects larger segments of the work force (9,15). One corporate analyst predicts that by 1990, nearly all manufacturing employees will spend 20 percent of the workweek in training programs to keep up with technology (15). A TRW Co. official states that, "In this decade, virtually all of the Nation's workers, most of whom are now employed, will need to be retrained or have their skills sharpened" (9). With the changing composition of the work force, many of those needing retraining will be both experienced and middle-aged.

Benefits from training and retraining

Employers report two major benefits from retraining: 1) more efficient use of human capital, and 2) retention of useful employees who might otherwise be hired by other companies. Other benefits to employers include reduction in the costs of recruitment and placement of new workers, decreased loss of productive employees through attrition, maximum utilization of worker skills, an upgrading of the quality of worklife of the retrainees, and company perpetuation (36). In discussing company perpetuation in this context, one researcher says that "retraining strengthens the economic life of a company and increases its ability to compete effectively. Retraining is an organizational mechanism that permits a company to be more things to more people" (36).

For example, one company offered an introductory course in electronics to older engineers, with course completion to be taken into consideration in determining pay increases. Also, since a limited number of engineers in each department could attend the course, a certain degree of status was associated with being selected. Maintenance technicians completing an electronics maintenance and repair course were given pay increases and higher status job titles. A company that retrained welders upgraded their job titles, and the union later won a salary increase for this group of crafts workers (52).

Costs of training and retraining

Little information is available on the financial costs of training, and nonfinancial costs or negative elements of training tend not to be addressed in the training and retraining literature.

Managers often ask what training costs, and whether the cost is justified. Answering these questions requires itemization of program costs. Usual budget categories include expenditures for training-staff time, special materials equipment, travel time for personnel to take special courses, consultant fees, state-of-the-art expenses such as conferences, and expenses for the training process itself, such as salary costs of the training. Once an accounting of the specific cost is performed, the organization can judge the program's worth (51).

Who pays for the costs of retraining and how will they be borne by the company? Costs are often associated with company size and industry type. The larger the organization, the greater the outlays. Major costs include wages and salaries paid to workers being retrained, the time spent by other employees on integrating trainees into the work of the organization, wear and tear on equipment, and higher accident or product rejection rates. In the context of adopting a philosophy about who should pay training costs, one expert notes that "under competitive conditions, all of the firm's costs will be charged to the worker if the training increases his future productivity in other firms as much as in the firm in which he is training. Some fraction of costs will not be charged to the worker if the training contains elements of specificity, that is if it increases the worker's future productivity in the firm more than in other firms" (26).

Methods of training and retraining

The focus of methods of training older workers has shifted in recent years. As recently as the late 1960s the older trainee was portrayed as one with special learning problems associated with age. Today, researchers and some employers consider older persons just as capable of learning new skills as younger persons, if the training occurs in a supportive environment. The work opportunities of older trainees, however, may be fewer.

Many methods for training are used by industry (see technical memorandum C). In deciding on the most appropriate method or group of methods for a given training program, management should consider: 1) what the trainee must do to successfully complete the program; 2) the extent to which trainees will be given an opportunity to discuss the training and measure their own progress; 3) the extent to which the trainers will be updated in their skills and given the chance to evaluate the training process; 4) the degree to which the training experience will approximate the job experience; 5) how the training method will adapt to differences in learning rates, availability of trainee time, and trainee attitudes; and 6) the cost of using the method(s) (51).

Concern about training the older worker first appeared in the mid-1960s in European publications; much of the literature that continues to be generated on this topic comes from Europe. In 1965, Belbin, the first expert to address the status of the older trainee, outlined difficulties shown by British workers in laboratory studies—problems associated with memory loss, rigidity in learning new material, lack of practice, and inadequate self-confidence. By the early 1970s, the literature posited that the older person does not necessarily face major problems in learning new skills, and that "in the past the problem has been that teachers did not adapt [to the needs of adult trainees] (3)." Learning success was described as being only partly dependent on the teaching method used with the older person. "The traditional methods of teaching based on exposition and presentation of theory followed by later application may work well with younger people . . . but it appears that these methods that are refined slowly through school life do not survive as natural and easy ways of learning once the individual has long left behind his schoolroom experience" (3).

An Aer Lingus (Irish Airlines) program is one example of retraining efforts created to meet the special needs of older workers. The airline changed an outdated cargo warehouse that used "shelves-and-forklifts" technology to a semi-automatic mechanism with electronically controlled storage and retrieval of freight and a computerized documentation system. Four elements in the retraining process were found to be valuable in retraining the older worker: 1) group participation by the trainees in using the new technology; 2) management's continuous communication with the workers on their progress and problems; 3) use of a "discovery method" of learning where the trainees learned about the new technology on their own, in contrast to learning through the lecture method; and 4) use of job-simulated experiences rather than abstract learning materials (29).

Factors affecting participation of older persons in retraining programs

The participation of older workers in retraining programs can be affected by requirements and conditions imposed by the training provider and by the attitudes and attributes of older workers themselves. Eligibility requirements and recruitment strategies often influence participation and vary from provider to provider. Employers consider job history or classification to be the most common eligibility requirement.

Often, as can be seen in the following case study examples, potential trainees must pass a screening test. When formal screening tests are not used, some providers screen possible participants to help ensure the success of training. Most providers claim they do not use age as a formal eligibility requirement. Years-of-service plays a minor role in determining eligibility; in some instances, workers participate in training sessions based on seniority. Income and employment status, e.g., being unemployed, are relevant in some cases. Though these conditions might only apply to the cases studied (see later section) they give an indication of the way companies are conducting recruiting for retraining.

Some of these eligibility criteria might work to the advantage of older workers while others might work against older workers. Years-of-service requirements, for example, might favor older workers, who often have longer tenure on the job. The use of formal screening tests might work against older workers whose education is less recent. Employers use a number of strategies to recruit and select participants for training. Some of these include a formal notification process as laid out in collective bargaining agreements, attendance at an initial information session, advertisement through company communication systems, and media or other third-party basis of disseminating information.

Employers may use both explicit and implicit incentives to encourage participation. Individuals successfully completing training may receive a salary increase, new personnel may receive wages while being trained, and classes may be offered free of charge. Implicit incentives related to job promotion possibilities and job security may also be provided.

Providers may also use informal encouragement or discouragement to guide individuals into or away from training opportunities, though there is no indication that this is used more often with older workers than with their younger counterparts.

Little research has been completed on factors affecting an older worker's participation in training and retraining. Twenty years ago, one study of a small sample of men identified four factors that tended to discourage workers from going to training: 1) family influence, 2) fatigue from evening classes, 3) latent apprehension about ability, and 4) nervous stress at the prospect of a more complicated job (30). A more recent study of printers (11) found that younger, healthier, and better educated men were more interested in learning new automated compositing techniques than were most older printers who were within 2 or 3 years of retirement. Both younger and older printers tended to base their interest in retraining on practical considerations—possibility for promotion or the cost of retraining prior to impending retirement.

Despite the paucity of factual data, the general perception is that older workers hold negative attitudes toward retraining. Some evidence suggests that older persons hold more negative attitudes toward automation than do younger people. Opinion Research Corp. found that unwillingness to accept increased automation in the workplace increased with age (15). Conversely, a General Motors executive believes that some older employees "have less fear of change than the young people coming along. I don't think acceptance of technology relates to age as much as it does to motivation (15)."

Providers often feel that attitudes related to retraining are likely to limit the participation of middle-aged and older persons in training programs. Apprehension about operating new machinery, skepticism about the outcomes of retraining, resistance to new technology, problems in rethinking how a job is done, momentum of involvement in work tasks that limit free time, and difficulty accepting young instructors were all identified by those asked in the case studies as attitudinal factors that might limit the older person's participation in training. Nevertheless, providers did not feel the attitudes of middle-aged and older workers were significantly different from those of younger workers or that they posed major problems.

Dissatisfaction with a current job might influence the older individual's decision to seek retraining, but voluntary withdrawal from the labor force can be economically difficult for many workers. The lack of wages or a stipend may be a *potential* barrier to retraining the unemployed. Although participants may be able to receive unemployment insurance in some States while attending the retraining program, this income may be inadequate for middle-aged and older participants with numerous financial obligations.

Case study examples of retraining

Several types of programs are available to train or retrain workers. Some are developed for use within a certain company while others result from cooperation among industry, government, and educational facilities. Companies have thus far initiated programs because the available labor pool does not have the needed skills or because it is advantageous to update or train workers in these skills. Most programs are not designed specifically for mature workers or older unemployed individuals; in fact, because organizations providing retraining seldom even collect detailed trainee age data, little information is available on the characteristics of retrainees.

For this report, two types of training were identified—pre-employment and post-employment training. Each could be provided in-house or by outside providers. Most of the representatives of the training programs, despite the program's orientation, did not believe that older workers needed different training than younger workers.

A number of retraining programs were examined. The case study examples cited here describe current training and retraining programs. Some cases were high technology companies or companies dealing with new technologies; others were not. Retraining was offered in order to update workers' skills. The electronic systems division of one large firm elected to retrain older employees instead of hiring new staff because retraining was believed to be less expensive. Fully 50 percent of the trainees were over age 40. The company found retraining both saved money in the long run by encouraging workers to continue working and kept needed skills within the company. One reason for deciding to retrain was that 40 percent of the company's work force would

Photo credit: Ted Horowitz

Retraining to update workers' skills benefits the company and the worker.

be eligible to retire within 10 years; the retirement of this segment was projected to be very costly. It was hoped that retraining would keep some workers on the job longer and thus stagger retirement benefit expenditures.

Another company was founded with the express purpose of training older executives to operate personal computers. As a result, more than 60 percent of the workshop attendees have been over 40.

Under the Investment in People Program, the State of California matches union and automobile manufacturers' funds to retrain unemployed auto workers at a trade and technical college. Entry-level electronics, welding, and diesel automotives are course topics.

Workers of all ages participated in those programs. Company officials found few failures, regardless of age, to complete the coursework; younger and older workers did equally well in the classes.

The future

The future of training and retraining for workers of all ages will depend largely on the availability of skills in the labor pool. To the extent that older workers have the needed skills to do jobs, they will not be candidates for retraining. However, the changing industrial and occupational structure indicates that many workers will need training to operate machines and production processes that have never before existed. Methods of doing some jobs will change as technology shifts, and workers will need to be trained to keep up with these changes.

The need for retraining programs depends less on the *current* balance of workers' skills vis-à-vis required skills than it does on the expected *future* skill balance. If the work force cannot adapt itself to changes in needed skills through educational institutions, and new production technology does not fully replace the need for human operators, retraining programs will become an essential and common practice (16).

If training programs become commonplace in future years, the question then becomes whether older workers will participate in these programs. Though older adults may have gained considerable on-the-job experience over the years, they are likely to need formal retraining to change jobs or to compete for jobs with workers who have more up-to-date skills.

Whether employers will target these workers for skills upgrading is unknown. Employers may choose to retrain older workers, as was seen in some case study examples, if they believe it is to their advantage to do so. They may also provide retraining programs for all workers in which large proportions of workers over 40 participate. Older workers may not, however, be specifically targeted for retraining, though they may need additional skills or retraining as job requirements change.

Other evidence suggests that workers may have decreasing opportunities for retraining as they age. Some employers surveyed in the case studies believed that it was more advantageous to retrain younger rather than older workers because older workers were more likely to retire. Other employers would rather offer attractive retirement benefits to workers at or near retirement age than offer to help update their skills (33).

There is substantial agreement that the need for training and retraining for workers of all ages will increase with the acceleration of technological innovation, but the approaches to meeting that need remain under debate.

The success of future training endeavors appears likely to depend in large part on the willingness of government, business, labor, educational institutions, and other training providers to collaborate, and for older workers to accept and seek retraining opportunities. Some experts believe no one sector has the resources or expertise to tackle the problem singlehandedly and that traditional education and training approaches have not succeeded for some population groups, including certain types of older workers. Adaptation of training methods to respond to the learning needs of these subgroups could change this pattern.

Technology, health, and physical capacity

Health and physical capacity are important aspects of an individual's ability and desire to work. Decline in either of these areas often leads to labor force withdrawal. Though its importance varies in different national surveys, poor health is one of the most frequently cited reasons for the decision to retire or otherwise withdraw from the labor force.

Many workers who retire for health reasons leave the labor force as a result of chronic conditions (e.g., cancer, diabetes, arthritis, or heart disease) (19), or because of physical impairments (permanent defects, usually static in nature). Still others leave work because of disability associated with chronic conditions, accidents, or injuries that limit their ability to work.

According to data from the National Center for Health Statistics, chronic conditions are more prevalent among those over 65 than among those 45 to 64. Women are more likely than men of the same age to suffer from most chronic impairments. Physical impairments that limit the ability to work include vision or hearing loss, absence of extremities, paralysis, or deformities and impairments of the back, or upper or lower extremities—all conditions that are more prevalent among those over 65.

The presence of chronic conditions may result in impaired functional ability, ranging from minor disability or limitation in activity to severe disability in which the individual is bedridden. Results of surveys regarding extent of disability in the population have varied over the years according to the ability of jobseekers to find employment at the time of the survey. They all agree, however, that a large majority of people 45 to 64 have no disabilities, and that more than half of those over 65 have none. Moreover, only small percentages of workers 45 to 64 and fewer than 1 in 5 people over 65 are unable to work due to physical disability (see app. E, table E-39).

The Retirement History Survey, which examined the relationship between individual characteristics and work disability, found that workers whose jobs were physically demanding were more likely to report disability than those whose jobs were less so, and that the existence of work limitations often led to withdrawal from the labor force (47). Disability rates also were higher for workers with fewer years of schooling; because they are likely to have physically demanding jobs, they are more vulnerable to work disability with advancing age. Disability rates for those over 50 were higher for women than for men.

Although physical limitations keep many from working, others continue to work even though they have minor illnesses. Days of activity restriction due to sickness averaged 31 days per year for all workers over 45 in 1978-79, according to the Health Interview Survey. This number rose from about 23 days per year for those 45 to 54 to 46 days for those over 75. Yet the number of days a worker actually stayed home from work due to sickness *decreased* with age—from 5 days per person per year for those 45 to 64 to 4 days for those over 65. Though people who are older and still working may be healthier than others of their same age—because those in poor health have left the labor force—older workers still miss fewer days of work than their younger counterparts.

Although the role of technology in disability rates and the general health and well-being of workers remains ill-defined, modern production and manufacturing processes, as well as the machines themselves, may contribute to many occupationally related deaths. The National Institutes of Health estimates that 5 to 10 percent of cardiovascular deaths, 15 to 25 percent of cancer mortality, and 10 percent of deaths due to pulmonary dysfunction may be attributable to the types of jobs workers do (4). New production methods that did not exist 50 years ago may induce or exacerbate health problems of workers who have done the same job for many years. Moreover, occupational exposure to hazardous manufacturing processes is often not manifested as disease for 15 to 25 years, and some conditions may not be present until well after retirement. As a result, many of the victims are older adults. Yet most epidemiological studies of occupational health do not include workers over age 55 in their samples (2).

Asbestos is a well-known example of a manufactured product that is correlated with occupational mortality. It is estimated that exposure to asbestos in shipyards and other industrial settings will be a factor in 2 million cancer deaths over the next 30 to 35 years (10).

Disease and impairment also result from technology in the workplace. Recent surveys of workers producing or working directly with asbestos found that 60 percent of older workers (mean age of 47.5 years) had some degree of respiratory limitation (4). Many chronic conditions in older adults, including hearing impairment, arthritis, respiratory problems, and dermatitis are either caused or made worse by the work environment.

Another example of technology-related impairment was observed in a study of workers required to perform repetitive motions using the wrist, such as might be experienced in assembly line work. Repetitive pressure, overexertion, and lifting, pulling, or throwing objects were found to result in injuries. These injuries can be quite costly; the mean cost per case for indemnity compensation was $1,026 and the mean cost per case for medical payments was $618. Heading the list for percent of wrist injury claims was the manufacturing industry (10.5 percent) followed by agriculture (5.4 percent). Since nearly one-third of men and one-fifth of women employed in manufacturing are between 45 and 64, older workers comprise a large at-risk group for such injuries.

Office automation may also disrupt physical health. Considerable controversy about health effects surrounds the use of video display terminals of minicomputers and word processing machines. When working over extended periods, some operators report visual strain or loss, and headaches. Back strain is also reported to result from inappropriate seating.

Work-related stress is another effect of technology. Computers are now capable of monitoring employee productivity, speed, and accuracy. For instance, the Communications Workers of America (CWA) notes that 150,000 of its members at American Telephone & Telegraph (AT&T), most of whom are operators using video display terminals, are now monitored for speed and accuracy by computer. CWA estimates that by 1985 half of AT&T workers will be so monitored. In addition, approximately 25 percent of the new retail sales cash registers have monitoring capability. Employers use these systems to measure the output of employees and determine production bottlenecks. Use of such equipment can increase productivity by as much as 20 to 100 percent (7).

Although this equipment means savings for employers, there are potential costs to the individual workers who use these systems. Monitoring can increase the anxiety and fatigue of workers and lead to depression. According to a 1980 Blue Shield study, extreme monitoring can make employees "psychologically sick." Researchers found a higher incidence of anxiety, depression, irritability, fatigue, and anger among 250 monitored employees when compared with 150 unmonitored workers. These symptoms have been associated with more serious problems such as coronary and gastrointestinal ailments (7). Signs of stress at work include fatigue, nervousness, sleeping disorders, loss of appetite, dissatisfaction with job or life, and use of tranquilizers, which may increase in prevalence as the use of monitoring increases.

Despite the fact that technologies in the workplace may contribute to deaths, injuries, and disabilities, a National Institute for Occupational Safety and Health (NIOSH) study found that only 3 percent of occupational disease cases result in worker's compensation claims (28). Thus, many workers may depend on private insurance to pay for occupationally related health problems or, if they have no insurance, pay their medical expenses out-of-pocket.

The future

Contrary to popular belief, there is growing evidence that the increasing proportions of people now living to the oldest ages are not necessarily healthier than their counterparts in the past (41). Tomorrow's older workers may thus be just as likely to become physically disabled and unable to work as today's older workers. The Federal Government is currently providing benefits to both retirees and the disabled; outlays for these benefits are likely to increase.

These patterns may, however, change for the better. Just as some workplace technologies may increase the risk of disability, others may reverse these negative health trends. The health of workers may improve in the future through greater understanding of physiological aging, medical technologies, better health habits and health maintenance technologies, and the careful implementation of workplace technologies. As current medical research intensifies and finds answers to some of the mechanisms of aging and disease, these answers will be disseminated by doctors, nurses, and other health care providers. Better and more efficient medical technologies will be developed to prevent or treat ailments more quickly. As society becomes better able to control health problems, overall health status may slowly improve. This will not, however, happen in the short term; decades are apt to pass before significant changes are seen.

Employers are becoming increasingly aware of the importance of a healthy work force. Absenteeism due to sickness can cost industry millions of dollars. In addition, the increasing costs of health care benefits have prompted employers to seek preventive measures to decrease these costs. Many companies are developing and implementing health promotion programs at the work site to improve the physical and mental well-being of their employees. Though good records are not kept and the effects of these programs have not been clearly documented, employers report many positive outcomes. For instance, an elaborate program at Pepsico Corp. has resulted in what company officials believe to be greatly improved productivity and attitudes of workers who take advantage of exercise facilities and employee health screening (49).

If the trend for employers to provide health promotion and disease prevention programs for workers continues, the workplace could become a major site for education and promotion of proper health habits. Improved health of employees, lower costs of health insurance, and additional years of productive work could result from these trends.

Workplace technologies can be a factor in improving worker health. The individual use of assistive devices can restore functional ability or compensate for physical deficits. (Technical memorandum A provides examples of currently used workplace devices.)

Technology can also improve worker health through the careful development, choice, and implementation of machines and production processes. Workplaces of the future could be designed to greatly reduce both accidents that may cause disability and exposure to noxious chemicals that may cause disease. Robots will increasingly be able to substitute for workers in dangerous jobs. Though some workers might, in theory, be displaced by automation, evidence suggests that the responsibilities of workers are usually shifted to other areas or jobs, depending on the types of occupations being examined (35). Moreover, retraining is not extensive in industry today, but both government and the private sector are giving retraining increased attention, and many programs have recently been initiated to retrain workers in new skills. Hence, controlled use of technology may significantly reduce physical injury and illness in the work force.

Technology thus has the potential to improve the health of all workers and safeguard the well-being of older adults. If the number of workers who retire prematurely due to poor health were to decline, individuals might still choose to retire at a predetermined age, but for different reasons. They could conceivably live their later years in better health and enjoy a greater sense of well-being. This positive effect could be important to government in that fewer dollars might be spent by Medicare and Medicaid for the care of the elderly.

Priority areas for research

Accurate information is needed about many aspects of worklife at older ages, including:

- specific, industry-by-industry effects of technological change on the older worker and the workplace;
- studies on attitudes and abilities that clearly delineate age subgroups of the older worker population;

- whether older workers are displaced as technology changes;
- precise epidemiological studies on the effects of hazardous working conditions on older workers;
- measurements of the capacities and abilities of older workers relative to those of younger workers;
- ways in which employer's perceptions affect employment and retraining opportunities for older workers;
- the physical and psychological effects of unemployment, displacement, discrimination, and retirement on the older worker; and
- the effects of employer and employee incentives and disincentives to hire or retain older workers.

Issues and options

ISSUE 1: Should Congress foster the use of assistive workplace devices so that older adults with physical limitations might remain in the work force?

Options:

1.1: Congress could maintain its present level of support for workplace devices, as in efforts by the National Institute of Handicapped Research (NIHR).

1.2: Congress could require AoA, NIA, NIOSH, or another agency to provide a means for manufacturers of workplace and other devices to inform employers and the public of the availability and existence of these technologies. This agency could be required to collect and assemble this information, assess the quality of these products, and disseminate the information to the public.

1.3: Congress could require coordination among NIHR, the VA, and other rehabilitation centers to promote and provide workplace technologies for older workers.

1.4: Congress could require demonstration projects (possibly using Older Americans Act Title V participants) to show effective use of workplace technologies. The components of this project could be:

- *research on the effectiveness of the devices,*
- *targeting to regions of high unemployment for older workers,*
- *targeting manufacturing and service industries (due to the high concentration of older adults working in these industries), and*
- *targeting to regions containing large proportions of older adults.*

1.5: Congress could require NIA, AoA, DOL, NIOSH, or another appropriate agency to develop cooperative ventures with organizations for the handicapped. This effort would focus on information collection and dissemination of material on workplace devices.

1.6: Congress could provide tax incentives to employers to use individual workplace devices, adapt working environments, and increase the purchase of assistive devices for use by older workers.

ISSUE 2: Should Congress devote resources to retraining older workers for new skills?

Options:

2.1: Congress could maintain its present level of support for older worker retraining. Current effort is concentrated in Title V of the Older Americans Act and the Job Training Partnership Act.

2.2: Congress could oversee the EEOC's enforcement of the Age Discrimination in Employment Act to ensure that employers provide equivalent retraining opportunities to older and younger workers.

2.3: Congress could encourage cooperative arrangements among educational institutions, corporations, and company-sponsored foundations to support research and demonstration projects to undertake retraining of older workers. Congress could provide financial assistance to educational institutions that cooperate with the private sector in developing training programs for older employees.

2.4: Congress could require AoA to fund retraining demonstration projects using trainers who are older, experienced, and highly specialized workers, such as members of the Senior Corps of Retired Executives.

2.5: Congress could provide financial, employment, and/or retraining assistance to older displaced workers through the following mechanisms:

- *Congress could finance more cooperative public/private training programs with special targeting to older employees. One important component would be a job-finding service upon completion of the courses.*
- *Congress could provide tax incentives to displaced workers to become retrained or take job-related educational courses.*

ISSUE 3: Should Congress foster the development of alternative work options?

Options:

3.1: Congress could maintain its current level of support for alternative work options.

3.2: Congress could reduce some of the barriers employers experience (e.g., heavier taxes for part-time workers, costly fringe benefits, etc.) when employing people other than full-time.

3.3: Congress could provide tax incentives for employers to develop more stable and permanent alternatives to full-time employment.

3.4: Congress could provide more low-interest loans, through such mechanisms as Small Business Administration loan programs, to individuals desiring to become self-employed. Persons over age 60 could be added to the target groups for receiving these loans.

Technical memorandum A: workplace devices[1]

This appendix contains examples of devices used by older workers at some worksites. Though these are more commonly used by handicapped individuals, they can be adapted for use by workers of any age who have some magnitude of physical or sensory deficit.

Device: Optacon.
Description: Compact portable reading system that converts image of a printed letter or symbol into a tactile form that can be felt with one finger.
Cost: $4,295. Additional lenses for CRT, calculator, typewriters, and magnification, $195 to $1,195.
Job tasks enhanced: Reading for severely visually impaired.
Advantages: Users report it to be a good machine. Allows blind persons to seek employment in wide variety of fields formerly closed to them.
Disadvantages: Cost. Requires special week-long training. Reading very slow with use of machine, blind may find it easier to have something read to them or tape recorded.
Available from: Telesensory Systems, Inc. (TSI).
Information sources: TSI. Fireman's Fund.

Device: Talking Computers.
Description: Speech synthesizers either incorporated in computer terminal circuitry or available as on-line adapters suitable for hookup to a variety of computer lines; provide speech output of data on monitor.
Cost: $4,500 to $5,000 (incorporated in terminal) $4,900 to $5,900 (device adapting to any terminal).
Job tasks enhanced: Computer or word processing activities by those with severe vision loss.
Advantages: Users report they generally work well. Translation accuracy of speech synthesizers about 90 percent.
Disadvantages: Cost. Some equipment does not provide speech for cursors, character attributes, or function codes. Speech quality varies.
Available from: Triformation Systems, Inc. Maryland Computer Services, Inc. Automated Functions, Inc
Information sources: Lawrence Livermore National Laboratory. Telesensory Systems, Inc. BYTE.

Device: Digit-Cal Talking Caliper.
Description: Adaptation of Brown & Sharpe digital caliper; audioizes measurement functions from digital readout.
Cost: $585.
Job tasks enhanced: Taking measurements for machinists, carpenters with total vision loss. Digital readout without speech synthesizer useful for people with minor or moderate visual impairment.
Advantages: Allows visually impaired persons to work in machinists and carpenters trades.
Disadvantages: Only one tool model available, which user found awkward. Nonvisually impaired machinists would only use it as a last resort. Talking box

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[1] Information from Birute Skurdenis, Western Gerontological Society (43).

breaks frequently and available working diagrams are inadequate to allow machine shops to repair it themselves.
Available from: American Foundation for the Blind.
Information sources: Lawrence Livermore National Laboratory. American Foundation for the Blind. Larsen.

Device: Talking Height Gauge.
Description: Adapted Brown & Sharpe tool hooked up to speech synthesizer. Measures heights with great deal of accuracy.
Cost: Unavailable.
Job tasks enhanced: Height measurements for machinists and carpenters.
Advantages: User reports it to be a very good tool.
Disadvantages: Prototype, not yet available on the market.
Available from: American Foundation for the Blind.
Information sources: American Foundation for the Blind. Lawrence Livermore National Laboratory. Larsen.

Device: Talking Cash Register.
Description: Digital display electronic cash register with speech synthesizer incorporated into circuitry.
Cost: Approximately $5,000.
Job tasks enhanced: Blind cashiers, participants in Randolph-Sheppard Blind Vendors Program.
Available from: R. C. Allen.
Information sources: American Foundation for the Blind. American Council of the Blind.

Device: Talking Dial Indicator.
Description: Adaptation of Brown & Sharpe tool used in lathe work. Plunger reads distance from perimeter to center of the object on lathe. Speech synthesizer produces speech output of measurements.
Cost: Unavailable.
Job tasks enhanced: Lathe work for visually impaired machinists and carpenters.
Disadvantages: Cost. Market for speech output adaptors has not yet developed.
Available from: American Foundation for the Blind.
Information sources: American Foundation for the Blind.

Device: Therm-Voice Talking Thermometer.
Description: Speech synthesizer provides speech output of digital thermometer readout. Probes available for clinical or high temperature use.
Cost: Unavailable.
Job tasks enhanced: Measuring temperatures for visually impaired photo lab developers, X-ray technicians, chemists, bakers.
Advantages: Flexibility, first introduced clinically, new uses discovered.
Available from: American Foundation for the Blind.
Information sources: American Foundation for the Blind.

Device: Braille Output Printer.
Description: Converter unit provides braille output translation for computer terminal operations.
Cost: Unavailable.
Job tasks enhanced: Computer access for blind persons trained in braille.
Disadvantages: Only 5 percent of those with visual impairments read braille.
Available from: Triformation Systems, Inc.
Information sources: Lawrence Livermore National Laboratory.

Device: Tactile Braille Markings on Dials.
Description: Information on machine dials, e.g., lathes, milling machines, surface grinders, translated and etched in braille markings.
Cost: Minimal.
Job tasks enhanced: Machinists and carpenter work.
Advantages: Easy to use; nonvisually impaired users of the machinery learn to use them rapidly.
Disadvantages: Not available; homemade. Time-consuming process and not feasible if dial is welded on. Need to be familiar with machinery in order to make accurate adaptation.
Information sources: Larsen.

Device: Talking Paper Money Identifier.
Description: Machine reads denomination of paper money and hookup with speech synthesizer provides speech output of information.
Cost: Unavailable.
Job tasks enhanced: Cashiers with severe visual impairment.
Information sources: American Foundation for the Blind.

Device: Versabraille.
Description: Portable information system that can receive, store, and reproduce notes in braille from previously stored information such as ordinary audio cassettes on which braille information has been recorded or on computer and word processing terminals and printers.
Cost: Unavailable.
Disadvantages: Only 5 percent of people with visual impairment read braille.
Available from: Telesensory Systems, Inc. (TSI).
Information sources: TSI.

Device: Talking Numerical Control Drill Press.
Description: Allows computer programming of measurement specifications for drilling. Hookup with speech synthesizer provides speech output of measurements.
Cost: Unavailable.
Job tasks enhanced: Allows metal and woodwork machinists who have severe visual impairments to remain at work.
Disadvantages: Cost of putting it together. Made on-site, not available commercially.
Information sources: Lawrence Livermore National Laboratory.

Device: Closed Circuit TV (CCTV) Magnification Systems.
Description: Closed circuit television receives signals from camera transmitter held over copy to be magnified up to 60 times. Special lenses are available for use with computer terminals, typewriters, and microfilm.
Cost: $1,895 to $4,495.
Job tasks enhanced: Paper processing, computer use for clerical or professional staff who have diminished visual ability.
Advantages: Users report it works well. Allows higher degree of magnification than magnifying glasses. CCTV technology widely used, including in surgical medicine and research.
Disadvantages: More machines are purchased by individuals, family, and through State rehabilitation agencies than by businesses.
Available from: Apollo Electronic Visual Aids. Visualtek.
Information sources: Hughes. Sandia. Apollo. Visualtek.

Device: Large Print Computer.
Description: Microcomputer with display capable of magnification from 2 to 16 times.
Cost: Unavailable.
Job tasks enhanced: Computer use by visually impaired persons.
Advantages: Switch enables use with or without magnification.
Available from: Visualtek.
Information sources: Visualtek.

Device: Magnifying Reading Glass with Illumination.
Description: Magnifying glass with small lamp attached underneath to provide extra illumination to material being magnified.
Cost: $15.
Job tasks enhanced: Reading.
Advantages: User response good. Extra illumination very useful for certain types of visual loss.
Available from: Bausch & Lomb.
Information sources: Sandia National Laboratory. Bausch & Lomb.

Device: Mounted Magnifying Glass.
Description: Six-inch diameter magnifying glass mounted on desk; able to swivel in a variety of positions.
Cost: $30 to $110.
Job tasks enhanced: Reading fine print or for partial visual impairment. Also used in electronics circuit board assembly. Can be used with computer readout and input.
Advantages: Users report it a good device.
Available from: Bausch & Lomb.
Information sources: Sandia National Laboratory. Fireman's Fund.

Device: Monoculars.
Description: Telescopic device with 8 x 20 magnification.
Cost: $50 to $60.
Job tasks enhanced: Person with partial visual loss can search files.
Advantages: Good, simple device.
Disadvantages: Often easier to relegate the task of file searching to another or to use a personally designed filing system with large markings.
Information sources: Sandia National Laboratory.

Device: Viewscan.
Description: Eighteen pound portable reading device, similar to CCTV, but screen is flat and small enough to fit in briefcase.
Cost: $3,500.
Advantages: User research found each feature was either very well liked or disliked by the users.
Disadvantages: Camera device that transmits information to viewer is sometimes difficult to use.
Available from: World Sensory Aids International.
Future: Video cassette books which will show print on Viewscan at speed and size desired by reader.
Information sources: Smith-Kettleweil.

Device: Telecommunications Devices for the Deaf (TDDs).
Description: A lightweight, portable printout or digital display unit with keyboard that connects by handset hookup to the telephone; allows hearing impaired persons to type and receive messages over the phone from other TDD users.
Cost: $500 to $1,000.
Job tasks enhanced: Telephone communications for severely or totally hearing impaired persons.
Advantages: Portability, many models can be packed into a briefcase and carried from home to office. Information available from local phone companies.

A San Francisco Post Office mailing center installed one to permit deaf employees to call in if sick or late. This improved employee relations because difficulties formerly experienced by deaf employees in contacting work had made them seem irresponsible.

Disadvantages: Most models in use can only communicate with other TDDs. TDDs tend to be available in urban communities. Businesses are slow to adopt their use because they cannot justify benefit for the cost. If users have no prior experience with telephones because of deafness from birth or early childhood, they must be trained in rudimentary use of telephones (dial tones, busy signals, information services).

Future: Communication through computer terminals. Speech synthesization.

Available from: Local telephone companies.

Information sources: DCARA. Lawrence Livermore National Laboratory. Pacific Telephone. AT&T.

Device: Volume Control Telephone Handset (Receiver).

Description: A telephone handset with adjustable volume control for reception.

Cost: $0.56/month extra telephone charge (northern California).

Job tasks enhanced: Telephone communication for partially deaf persons.

Advantages: Inexpensive, most widely used of all devices for the hearing impaired.

Available from: Local telephone companies.

Information sources: DCARA. Hughes. AT&T.

Device: Amplified Speech Handset.

Description: Telephone handset with adjustable volume control for speech transmission.

Cost: Unavailable.

Job tasks enhanced: Communication for people who can only speak in soft voices.

Disadvantages: Very limited use.

Available from: Local telephone companies

Information sources: AT&T.

Device: 5C Electronic Larynx.

Description: Device held to throat vocalizes throat sounds.

Cost: Unavailable.

Job tasks enhanced: Communication for people with laryngectomies who have not learned to vocalize or an assist for those who have.

Available from: Local telephone companies.

Information sources: AT&T.

Device: Canon Communicator Mark II.

Description: Portable communication aid for nonoral, motor-impaired persons. Letters/symbols are selected on communicator's keyboard and are printed on paper tape display.

Cost: Unavailable.

Job tasks enhanced: Communication for people with both oral and motor impairment due to cerebral palsy, stroke, etc.

Available from: Telesensory Systems Inc. (TSI).

Information sources: TSI.

Device: Tilt-top Work Table.

Description: 12" by 18" table top with adjustable height and tilt. Load capacity of 40 pounds. Elastic straps to hold material in place.

Cost: $28 to $37.

Job tasks enhanced: Electronic assembly, typing, and reading; holds computer printout-size material.

Advantages: Flexible use for different needs.

Available from: Able/Table Weir Enterprises.

Information sources: Tektronix. Weir Enterprises.

Device: Splints and Finger Gloves.

Description: Splints for wrist and elbow support. Finger gloves to fit one finger and provide protection when handling threads at high speeds.

Cost: Minimal.

Job tasks enhanced: Sewers and cutters in textile industry. Sewers and mechanics working with high-speed threads.

Advantages: Splints give support for repetitive actions. Finger gloves provide protection from soft-tissue deterioration resulting from constant use in the same pattern of action; can be easily constructed using soft leather. Combining a glove or arm covering with the device provides warmth for improved circulation.

Available from: Prepared by rehabilitation counselor.

Information sources: Rehabilitation in Industry.

Device: Foam Sponge Grip.

Description: Piece of foam with hole cut through center slips around objects such as pens and knives to widen grip.

Cost: Minimal.

Advantages: Inexpensive. Can be constructed by anyone.

Available from: Prepared by rehabilitation counselor.

Information sources: Rehabilitation in Industry.

Device: Truck Cab Alarm System.

Description: Various systems to maintain driver alertness. Device mounted on vehicular equipment measures normal seat or steering wheel movements. A change in these movements sounds alarm. Device mounted on person registers alarms when head tilts in certain way.

Cost: Unavailable.

Job tasks enhanced: Driving alertness.

Advantages: Unobtrusive device that promotes safety and saves lives.
Disadvantages: Products not reliable. Not proven cost effective.
Information sources: International Brotherhood of Teamsters.

Device: Vibrating Truck Cab Seat.
Description: Driver's seat provides gentle vibration to keep blood from collecting in lower extremities. Keeps driver alert and improves blood circulation.
Cost: Unavailable.
Job tasks enhanced: Driver alertness, especially in long-haul trucking.
Disadvantages: Not proven cost effective or necessary.
Information sources: International Brotherhood of Teamsters.

Technical memorandum B: industries in detail

Agriculture, forestry, fisheries
Mining:
  metal and coal mining
  oil and gas extraction
  nonmetallic minerals except fuel
Construction:
  general building, heavy construction, and special trade contractors
Manufacturing:
  Durable goods:
    lumber and wood products
    furniture and fixtures
    stone, clay, and glass products
    primary metals industries
    fabricated metals
    machinery except electrical
    electric and electronic equipment
    transportation equipment
    instruments and related products
    miscellaneous, i.e., jewelry, toys, and writing implements
  Nondurable:
    food and kindred products
    tobacco
    textile mill products
    apparel
    paper and allied products
    printing and publishing
    chemicals and allied products
    petroleum and coal products
    rubber and miscellaneous plastic products
    leather and leather products
Transportation, communication, and other public utilities:
  railroads
  local and interurban transport
  trucking and warehousing
  air transport
  pipelines
  transportation services
  communication
  electric, gas, and sanitary services
Wholesale and retail trade:
  Wholesale trade
  Retail trade:
    general merchandise stores
    food stores
    apparel stores
    furniture and home furnishings stores
    eating and drinking places
Finance, insurance, and real estate:
  banking
  credit agencies
  security, commodity brokers
  insurance carriers
  real estate
Services:
  personal services
  business services
  motion pictures
  health services
  hotels
Public administration:
  Federal Government
  State and local government

Technical memorandum C: training methods[1]

Among the most widely used training methods in industry are: 1) lecture, 2) structured discussion, 3) unstructured discussion, 4) on-the-job training, 5) vestibule training, 6) case study, 7) incident process, 8) role-play, 9) in-basket exercise, 10) simulation, 11) management games, and 12) programmed instruction.

The first four techniques are self-explanatory; the remaining methods require some description. Vestibule training is on-the-job training (OJT) in an area where work is not being performed, freeing the trainee of the pressures created by the OJT experience. In the case study method, the trainee learns through analyzing and solving problems identified in a documented description of a real job situation. Incident process, a variation of the case study, requires the trainee to add needed information and solutions to a partially explained work incident. Role-play permits the trainee to play-act working at the new job, as well as act out the roles of others at the work place. In-basket exercise is an appropriate method for training persons who will be dealing with a large load of documents. The trainee is presented with examples of materials for review and is asked to respond to each of them. Simulation is a version of OJT. Rather than work in the job environment, however, the trainee practices the tasks of the new job in a controlled work situation. Management games use the model of a business situation. Trainees are asked to play out the roles of managers in competing organizations. Lastly, programmed instruction involves the presentation of information to be learned in a series of short, sequential steps. The trainee continues to respond to the questions in the series until the desired skill is mastered (51).

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[1] Information from Paul and Coberly (33).

Technical memorandum D: projected job growth rates in high-technology industries[1]

Projected job growth rates vary greatly among high-technology industries. Computer and data processing services, and research and development laboratories, the only manufacturing industries in the high growth group, are estimated to show some of the largest annual rates of increase—5.2 and 3.9 percent respectively. Other rapid gainers are medical and dental instruments (4.2 percent), office and computing machines (3.7 percent), electronic components (3.2 percent), and engines and turbines (3.1 percent). By contrast, chemical industries and petroleum refining are projected to have substantially lower growth rates because of oil price effects. Employment in petroleum refining is projected to decline by 1.6 percent per year between 1982 and 1995.

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[1] Information from Personick (34).

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Appendixes

Appendix A

Morbidity and Mortality Data

Introduction

The "graying" of the population in the 20th century is a well-documented phenomenon (see ch. 2). Scrutiny of trends in the major causes of death (mortality) and in the prevalence[1] of certain chronic illnesses (morbidity) that are known to increase with age may help to better prepare our medical, research, and social service resources to meet the health needs of the growing elderly population.

Comparison of trends in morbidity and mortality for specific conditions can often yield valuable clues to their underlying forces. For example, while the death rates from both heart disease and diabetes have generally fallen among the elderly in recent years, their prevalence as chronic conditions has risen. The reason for this divergence is unclear, but probably involves better treatment of ongoing symptoms of the chronic condition along with improved medical treatment for acute episodes. Better acute care keeps the death rate down but also may add to chronic illness through the after-effects of the acute episode. Since chronic disease causes most disability and usurps a large portion of our health care resources (see section on "Morbidity"; also, ch. 8), such trends have important implications for government policy.

This appendix analyzes the age, gender, and race differences in such trends among persons 65 and over. Given the often striking heterogeneity among the elderly in terms of health status and risk, health policy could be more effectively targeted towards certain high-risk subgroups. Correlation of these trends in morbidity and mortality with changes in behavioral and environmental risk factors is attempted where possible. Many risk factors are controllable and have implications for public health promotion and education (see ch. 4).

Appendix B: Cell Biology of Aging presents theories of biological aging as a chronological process distinct from age-related disease, and outlines what is known and not known about the aging process. A better understanding of the mechanisms underlying aging, and their possible involvement in the relatively high prevalence of certain diseases in the elderly, may lead to medical technologies that can delay the onset and progression of both aging and age-related diseases (see ch. 2). These advances could improve the general health and productivity of the growing proportion of people who reach old age.

First the limitations of the data are discussed, followed by sections on trends in mortality and morbidity and ending with a brief summary of the conclusions that may be drawn from this analysis.

Limitations of the data

This chapter is based largely on U.S. data collected by the National Center for Health Statistics (NCHS). Because some States did not participate in the death registration program until 1933, most of the mortality data used in this appendix is dated from 1940 onward. Comparison of mortality and morbidity data from different years is further limited by the numerous revisions of the International Classification of Diseases (ICD) since 1900 (a total of nine, one every 7 to 10 years). Comparability ratios that account for these classification changes are available for the rates of most major causes of death to allow more accurate trend analysis. No such ratios are available for data on prevalence of chronic conditions, however, and comparisons of morbidity data are thus generally limited to the period of the eighth ICD revision (1968-78).

Analysis of morbidity trends is further complicated by the tendency of the elderly to develop multiple disorders and to manifest symptoms different from those of younger people. Diagnosis can thus be more difficult, with implications for both the accuracy of the data and, most importantly, for health care delivery. Moreover, as diagnostic practices and public awareness of certain conditions improve, rates of both morbidity and mortality may be raised by increased detection of chronic cases and of principal (v. contributing) causes of death, as is discussed further in the text.

Mortality

TRENDS IN GENERAL DEATH RATES

Death rates among the elderly have declined progressively since 1900; during some periods there have been dramatic changes (figs. A-1 and A-2). From 1940 to 1978, the age-adjusted[2] death rate for the elderly fell by 38 percent (table A-1). Following a sharp drop during the 1940-54 period, when the *annual* decline averaged 1.5 percent, this rate leveled off between

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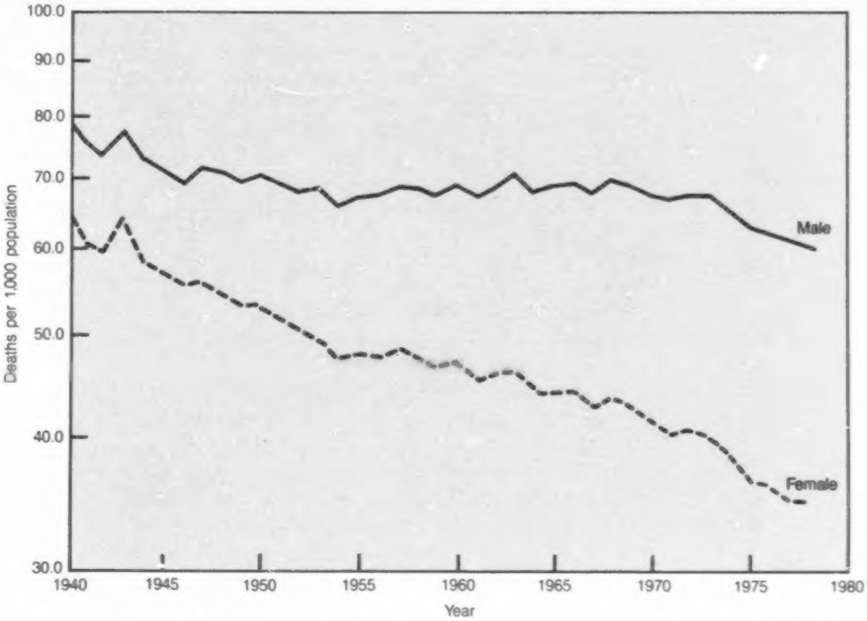
[1] Prevalence is the estimated average frequency of an event or condition occuring within a population during a specified period of time, which in this report is usually 1 year.

[2] "Age-adjusted" means that age-specific rates are weighted according to the age distribution of the population in a given reference year (see ch. 2).

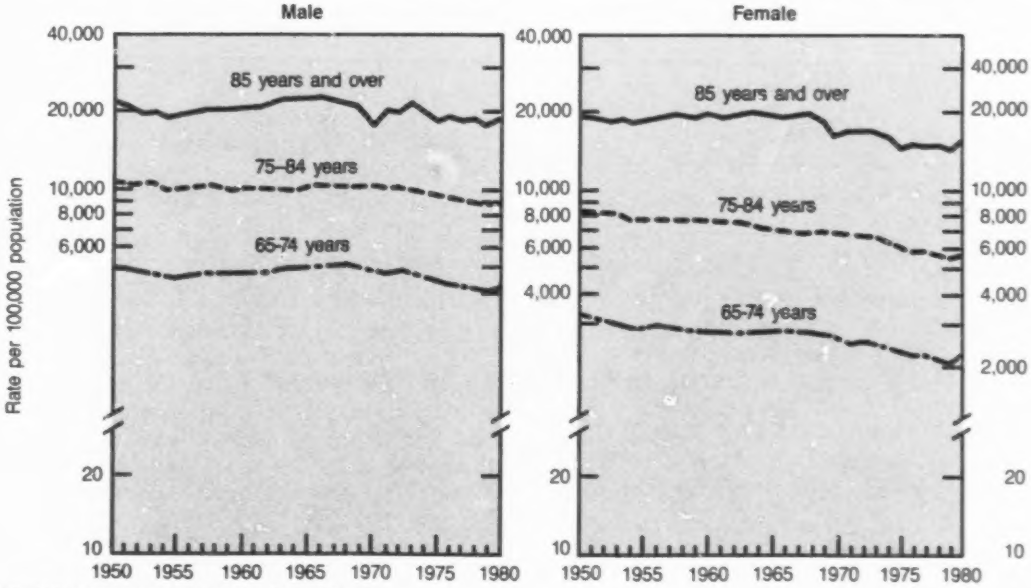
Figure A-1.—Age-Adjusted Death Rates Among Persons Aged 65 and Over, by Sex: United States, 1940-78



NOTES: Age adjusted by the direct method to the population aged 65 and over in the United States as enumerated in 1940, using 5 age groups. Death rates for the group aged 85 and over in 1970 used in computation of rates are based on population estimates revised by the U.S. Bureau of the Census to correct for overestimates of the group aged 100 and over.

SOURCE: Adapted from U.S. DHHS, NCHS, 1982 (63).

Figure A-2.—Death Rates Among Persons Aged 65 and Over for All Causes, by Sex and Age: United States, 1950-80



SOURCE: Adapted from U.S. DHHS, NCHS, 1983 (67).

Table A-1.—Age-Adjusted Death Rates for Males and Females Aged 65 and Over: United States, 1940 and 1978

Sex	Age adjusted 1940	Age adjusted 1978	Age adjusted Percent change
Both sexes	72.2	45.0	-37.7%
Male	79.5	60.0	-24.5
Female	65.3	34.8	-46.7

SOURCE: U.S. DHHS, NCHS, 1982 (63).

1955 and 1967, then decreased sharply once again between 1968 and 1978 at an average rate of 2.0 percent a year (63). The percent change was similar for all age-specific subgroups, ranging from -35.4 percent for the 85 and over group to -44.4 percent for those 75 to 79 (table A-2).

GENDER DIFFERENCES IN DEATH RATES

The decline in death rates over the past century is more pronounced for women than for men, as shown

Table A-2.—Death Rates Among All Persons Aged 65 and Over, by Selected Age Groups: United States, 1940-78, 1980

Year	65–69 years	70–74 years	75–79 years	80–84 years	85 years and over
	Deaths per 1,000 population				
1940	39.7	61.1	94.8	145.6	235.7
1941	37.9	58.2	88.4	139.6	218.7
1942	37.0	56.5	84.9	134.3	211.1
1943	37.5	58.8	89.9	142.2	230.3
1944	35.7	55.9	85.9	133.0	215.3
1945	34.8	53.9	84.5	125.7	209.6
1946	33.5	52.2	82.3	120.1	210.6
1947	34.2	53.5	84.0	121.8	216.9
1948	33.8	52.3	82.5	118.8	213.2
1949	33.5	51.3	80.6	116.3	203.2
1950	33.8	51.5	78.9	120.9	202.0
1951	33.0	50.3	78.2	119.1	197.6
1952	32.6	49.2	76.4	117.4	190.6
1953	32.7	49.0	75.8	118.9	191.9
1954	31.4	46.9	72.1	112.3	181.6
1955	31.7	47.0	73.7	114.7	189.8
1956	31.7	46.7	73.1	115.2	192.3
1957	32.6	47.7	73.1	115.9	197.9
1958	31.9	47.0	72.9	116.2	198.0
1959	31.1	46.1	71.0	114.1	194.2
1960	31.4	47.2	72.0	117.2	198.6
1961	30.7	45.0	69.5	111.3	196.3
1962	31.1	45.4	70.7	111.7	204.9
1963	31.3	46.1	71.9	112.8	209.9
1964	30.3	44.5	69.4	108.0	199.2
1965	30.5	44.2	69.8	108.1	200.7
1966	30.6	44.9	69.8	107.8	199.8
1967	29.9	44.1	67.8	104.0	192.2
1968	30.8	45.3	69.5	106.4	195.8
1969	30.2	44.1	67.3	104.6	188.2
1970	29.7	43.7	67.2	101.6	175.4
1971	28.6	43.0	66.3	99.0	174.3
1972	28.8	44.0	67.5	99.1	173.5
1973	28.0	43.0	67.2	97.8	174.3
1974	27.0	41.9	64.5	94.7	165.3
1975	25.7	40.5	62.1	91.0	151.9
1976	25.4	39.5	61.9	90.3	154.9
1977	24.8	38.5	60.7	88.1	147.3
1978	24.6	37.9	60.2	89.5	147.0
1980	24.6	36.8	55.0	86.4	159.8
Percent change 1940–80	-39.3%	-39.8%	-44.4%	-40.7%	-35.4%

SOURCE: U.S. DHHS, NCHS, 1982 (63) and 1983 (67).

in figure A-1 The age-adjusted decline from 1940 to 1978 for elderly women was 47 percent, almost twice the decline of 24 percent for elderly men in the same period (table A-1). The percent change in the death rate was less for women over 80 in this period (table A-3). The percent decline for every age group of elderly men was smaller than that for women (table A-4). Correspondingly, the increase in life expectancy at age 65 for women (+35 percent) from 1940 to 1978 was more than twice as great as that for men (+16 percent) (63).

Furthermore, the ratio of death rates for elderly men to those of elderly women has increased steadily over the years but more slowly in the older age groups (table A-5). The annual increase in the ratio for the "younger" elderly subgroups dropped between 1968 and 1978 as a result of the accelerating decline in the general death rate of elderly men under age 80 (63).

RACE DIFFERENCES IN DEATH RATES[3]

Death rates for elderly black women and elderly whites of both sexes fell between 1950 and 1980 (table A-6). The decline for whites was greater than that for

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[3] This report often distinguishes between white and black or white and "all other races" depending on the available statistics and the significance of the difference between the subgroups. Since the "all other" population is approximately 95 percent black, these two categories are roughly comparable.

Table A-3.—Death Rates Among Females Aged 65 and Over, by Selected Age Groups: United States, 1940-78, 1980

Year	65–69 years	70–74 years	75–79 years	80–84 years	85 years and over
	Deaths per 1,000 population				
1940	33.9	54.3	86.5	136.0	227.6
1941	32.0	51.1	80.3	129.2	208.8
1942	30.9	49.8	77.0	124.3	202.9
1943	31.7	51.8	81.7	131.9	221.2
1944	29.9	49.3	77.8	124.3	207.8
1945	28.9	47.0	76.3	116.7	201.3
1946	27.6	45.8	74.2	112.0	203.0
1947	27.7	46.2	75.2	113.2	207.2
1948	27.0	44.7	73.5	110.0	203.1
1949	26.6	43.6	71.1	106.6	194.4
1950	26.4	43.2	69.6	110.7	191.9
1951	25.4	41.8	68.8	108.6	190.1
1952	25.0	41.0	67.1	105.7	186.1
1953	24.9	40.5	66.0	107.1	186.6
1954	23.7	38.2	62.7	100.6	177.4
1955	23.9	37.7	63.8	102.9	185.5
1956	23.7	37.3	63.0	103.2	186.6
1957	24.1	37.8	62.9	104.4	191.5
1958	23.4	37.3	62.2	104.6	191.0
1959	22.7	36.2	60.5	102.9	186.8
1960	22.6	36.7	60.7	105.3	190.1
1961	21.9	35.0	58.2	99.5	186.9
1962	22.0	35.1	59.0	99.7	194.0
1963	22.0	35.2	59.4	99.8	197.9
1964	21.4	33.7	57.1	95.4	189.1
1965	21.4	33.1	57.0	94.7	189.0
1966	21.5	33.6	56.9	94.3	188.5
1967	21.0	32.7	54.8	90.6	180.4
1968	21.5	33.3	56.1	92.8	184.3
1969	20.9	32.6	54.0	90.6	177.1
1970	20.4	32.4	53.8	87.7	163.5
1971	19.5	31.8	52.8	85.0	162.2
1972	19.8	32.4	53.5	84.7	162.0
1973	19.0	31.6	53.4	83.4	162.3
1974	18.2	30.7	51.1	80.9	153.9
1975	17.3	29.5	48.8	76.9	140.3
1976	17.1	28.6	48.5	76.3	143.1
1977	16.9	27.7	47.4	73.9	135.4
1978	16.9	27.2	47.1	75.1	135.4
1980	17.2	26.7	42.6	72.6	147.5
Percent change 1940–80	–49.3%	–50.8%	–50.7%	–46.6%	–35.2%

SOURCE: U.S. DHHS, NCHS, 1982 (63) and 1983 (67).

Table A-4.—Death Rates Among Males Aged 65 and Over, by Selected Age Groups: United States, 1940-78, 1980

Year	65–69 years	70–74 years	75–79 years	80–84 years	85 years and over
	Deaths per 1,000 population				
1940	45.5	68.0	103.7	156.6	246.4
1941	43.9	65.5	97.2	151.8	231.9
1942	43.1	63.3	93.7	146.1	222.1
1943	43.5	66.0	99.0	154.6	242.6
1944	41.6	62.9	94.8	143.6	225.5
1945	41.0	61.0	93.7	136.6	220.7
1946	39.7	59.0	91.4	129.9	221.1
1947	41.0	61.3	93.9	132.0	229.3
1948	40.9	60.4	92.7	129.6	226.4
1949	40.8	59.6	91.3	128.1	215.0
1950	41.6	60.6	89.6	133.4	216.4
1951	41.1	59.7	89.1	132.1	208.2
1952	40.7	58.3	87.3	132.5	196.7
1953	41.0	58.5	87.1	134.4	199.2
1954	39.8	56.7	83.3	127.5	187.4
1955	40.2	57.5	85.4	130.3	195.9
1956	40.5	57.5	85.3	131.3	200.5
1957	42.0	59.0	85.6	131.4	207.3
1958	41.4	58.2	85.9	132.0	208.3
1959	40.7	57.6	84.0	129.5	205.4
1960	41.4	59.5	86.2	133.7	211.9
1961	40.8	56.9	83.9	127.9	210.8
1962	41.6	57.8	85.6	128.7	222.5
1963	42.4	59.6	88.1	131.3	229.4
1964	41.0	58.0	85.6	126.4	216.4
1965	41.4	58.3	87.0	128.1	220.8
1966	41.7	59.4	87.4	128.0	220.1
1967	40.7	59.1	85.8	124.6	213.4
1968	42.2	61.3	88.4	127.6	217.3
1969	41.6	59.6	86.4	126.8	208.8
1970	41.2	58.9	86.8	123.9	197.7
1971	39.9	58.2	86.2	122.1	197.5
1972	40.0	59.8	88.4	123.4	196.0
1973	39.3	58.7	88.1	122.4	198.1
1974	38.0	57.2	85.1	118.6	188.8
1975	36.4	55.6	82.5	115.9	175.7
1976	35.9	54.3	82.6	115.2	179.8
1977	34.7	53.2	81.5	113.6	173.0
1978	34.4	52.4	80.7	116.0	172.6
1980	33.9	50.8	74.8	112.4	188.0
Percent change 1940–80	–25.5%	–25.3%	–27.9%	–28.2%	–23.7%

SOURCE: U.S. DHHS, NCHS, 1982 (63) and 1983 (67).

Table A-5.—Mortality Sex Ratios[a] Among Persons Aged 65 and Over, by Selected Age Groups: United States, 1940-78, 1980

Year	65 years and over[b]	65–69 years	70–74 years	75–79 years	80–84 years	85 years and over
	Ratio					
1940	1.22	1.34	1.25	1.20	1.15	1.08
1941	1.24	1.37	1.28	1.21	1.17	1.11
1942	1.24	1.39	1.27	1.22	1.18	1.09
1943	1.24	1.37	1.27	1.21	1.17	1.10
1944	1.24	1.39	1.28	1.22	1.16	1.09
1945	1.26	1.42	1.30	1.23	1.17	1.10
1946	1.25	1.44	1.29	1.23	1.16	1.09
1947	1.28	1.48	1.33	1.25	1.17	1.11
1948	1.30	1.51	1.35	1.26	1.18	1.11
1949	1.32	1.53	1.37	1.28	1.20	1.11
1950	1.34	1.58	1.40	1.29	1.21	1.13
1951	1.35	1.62	1.43	1.30	1.22	1.10
1952	1.35	1.63	1.42	1.30	1.25	1.06
1953	1.37	1.65	1.44	1.32	1.25	1.07
1954	1.39	1.68	1.48	1.33	1.27	1.06
1955	1.39	1.68	1.53	1.34	1.27	1.06
1956	1.41	1.71	1.54	1.35	1.27	1.07
1957	1.42	1.74	1.56	1.36	1.26	1.08
1958	1.43	1.77	1.56	1.38	1.26	1.09
1959	1.44	1.79	1.59	1.39	1.26	1.10
1960	1.47	1.83	1.62	1.42	1.27	1.11
1961	1.49	1.86	1.63	1.44	1.29	1.13
1962	1.50	1.89	1.65	1.45	1.29	1.15
1963	1.53	1.93	1.69	1.48	1.32	1.16
1964	1.54	1.92	1.72	1.50	1.32	1.14
1965	1.57	1.93	1.76	1.53	1.35	1.17
1966	1.57	1.94	1.77	1.54	1.36	1.17
1967	1.59	1.94	1.81	1.57	1.38	1.18
1968	1.61	1.96	1.84	1.58	1.38	1.18
1969	1.62	1.99	1.83	1.60	1.40	1.18
1970	1.64	2.02	1.82	1.61	1.41	1.21
1971	1.66	2.05	1.83	1.63	1.44	1.22
1972	1.66	2.02	1.85	1.65	1.46	1.21
1973	1.68	2.07	1.86	1.65	1.47	1.22
1974	1.69	2.09	1.86	1.67	1.47	1.23
1975	1.72	2.10	1.88	1.69	1.51	1.25
1976	1.72	2.10	1.90	1.70	1.51	1.26
1977	1.73	2.05	1.92	1.72	1.54	1.28
1978	1.73	2.04	1.93	1.71	1.54	1.27
1980	—	1.97	1.90	1.76	1.55	1.28

[a] Ratio of male death rate to female death rate.

[b] Age adjusted by the direct method to the population 65 years of age and over as enumerated in 1940 using 5 age groups.

SOURCE: U.S. DHHS, NCHS, 1982 (63) and 1983 (67).

Table A-6.—Death Rates[a] by Sex, Age, and Race: United States, 1950-80

	Male						Female					
	White			Black			White			Black		
Year	65–74	75–84	85 and over	65–74	75–84	85 and over	65–74	75–84	85 and over	65–74	75–84	85 and over
1950	48.6	105.3	221.2	53.1	*101.0*[b]		32.4	84.8	196.8	40.6	*83.5*[b]	
1960	48.5	103.0	217.5	58.0	86.0	148.4	27.8	77.0	194.8	40.6	67.3	130.5
1965	48.3	102.4	227.3	56.5	89.8	159.7	25.8	71.3	193.5	37.4	66.2	131.4
1970	48.1	101.0	203.9	58.0	94.5	144.1	24.7	67.0	167.3	38.6	66.9	121.3
1975	43.6	96.1	182.6	52.3	93.4	124.5	21.5	60.3	144.9	33.1	64.2	95.6
1978	41.3	94.2	181.0	48.7	102.6	113.8	20.6	58.1	140.8	29.2	72.4	87.9
1980	40.4	88.3	191.0	51.3	92.3	161.0	20.7	54.0	150.0	30.6	62.1	123.7
Percent change, 1950–1980	−16.9	−16.1	−13.6	−3.4	+7.3[c]	+8.5[c]	−36.1	−36.3	−23.8	−23.5	−7.7[c]	−5.2[c]

[a] Number per 1,000 population.

[b] Italic numbers are for the 75 and over group.

[c] Percent change calculated for 1960–80.

SOURCE: Adapted from U.S. DHHS, NCHS, 1982 (65) and 1983 (67).

blacks in all age groups. While the rate for black men 65 to 74 also fell during this period, the rate for those over 75 actually rose after 1960.

Death rates were consistently lower for whites from 1960 to 1980 in the 65 to 74 age group but lower for blacks in the over-85 group. In the 75 to 84 group, however, the black death rate was lower for women through 1970 and for men through 1975, after which both rates rose to surpass the rates for whites. The reasons for these race differences in death rates among the elderly remain largely unknown. Suggestions include race differences in accuracy of age reporting and the possibility that very old black persons are more likely than whites to be healthy (see ch. 2).

TRENDS IN MAJOR CAUSES OF DEATH

The trends in the major causes of death that underlie the falling death rates since the turn of the century are significant indicators of the efficacy of improvements in public health, health care practices, and medical technology. Such changes are also useful in predicting future trends in order to anticipate how the Nation's medical, social service, and health promotion systems should prepare to meet changing needs.

Since the turn of the century, the major causes of death among the elderly and in the general population have shifted from infectious diseases to cardiovascular diseases and cancer (tables A-7 through A-9). Although mortality data before 1933 are incomplete, the available figures cite tuberculosis and "pneumonia and influenza" as the leading killers of people of all ages until 1920 (NCHS, unpublished data). These three diseases alone are estimated to have caused approximately 23 percent of all deaths in 1900 (table A-7). The decline in infectious disease can be attributed largely to improved public sanitation, the advent of vaccines, greater accessibility to health care for all subgroups of the population, and the development of antibiotic treatments. Pneumonia and influenza, however, are still ranked fourth as cause of death among the elderly and sixth in the general population.

The three current leading causes of death both in the general population and among those over age 65 are diseases of the heart, malignant neoplasms (cancer), and cerebrovascular disease (stroke), in that order (tables A-8 and A-9). These three conditions accounted for three out of every four deaths among the elderly both in 1950 and 1978 (63). Of the top 10 causes of death among the elderly today, only cancer and chronic obstructive lung disease are increasing.

Diseases of the Heart.—Heart disease has been the leading cause of death in the general population as well as among the elderly since the 1920s. The death rates for heart disease increase progressively with age in men and women, peaking in the 85 and over group (fig. A-3, table A-10). Cardiovascular disease in general affects 50 percent of those over 70, but only 11 percent of those under 40 (37).

Death rates for heart disease declined very rapidly among the elderly in the 1968-78 period; annual decreases averaged 2 percent (63). The decline from 1950 to 1978 was consistently greater for elderly women than men and generally less in the older age groups (table A-10). The male-female ratio of death rates for heart disease increased for all age groups over the period and is most pronounced in the 65 to 74 age group (table A-11). The differences in both current rate and decline between the sexes were smaller in the older age groups, however.

There are also significant race differences in heart disease mortality: elderly white men exhibit higher rates than black men in most age groups; white wom-

Table A-7.—Major Causes of Death: United States, 1900

Rank order			Number	Rate[a]	Percent of all deaths
	All causes		343,217	1,719.1	
1	Pneumonia (all forms) and influenza	107–109,33	40,362	202.2	11.8%
2	Tuberculosis (all forms)	13–22	38,820	194.4	11.3%
3	Diarrhea, enteritis, and ulceration of the intestines	119,120	28,491	142.7	8.3%
4	Diseases of the heart	90–95	27,427	137.4	8.0%
5	Intracranial lesions of vascular origin	83	21,353	106.9	6.2%
6	Nephritis (all forms)	130–132	17,699	88.6	5.2%
7	All accidents	169–195	14,429	72.3	4.2%
8	Cancer and other malignant tumors	45–55	12,769	64.0	3.7%
9	Senility	162	10,015	50.2	2.9%
10	Diphtheria	10	8,056	40.3	2.3%

[a] Per 100,000 people.

SOURCE: National Center for Health Statistics, unpublished data.

Table A-8.—Deaths and Death Rates[a] for the 10 Leading Causes of Death: United States, 1980

Rank order	Cause of death[b]	Number	Rate	Percent of all deaths
	All ages			
...	All causes	1,989,841	878.3	100%
1	Diseases of heart . . . 390–398, 402, 404-429	761,085	336.0	38.2
2	Malignant neoplasms, including neoplasms of lymphatic and hematopoietic tissues . . . 140–208	416,509	183.9	20.9
3	Cerebrovascular diseases . . . 430–438	170,225	75.1	8.5
4	Accidents and adverse effects . . . E800–E949	105,718	46.7	5.3
...	Motor vehicle accidents . . . E810–E825	*53,172*	*23.5*	*2.7*
...	All other accidents and adverse effects . . . E800–E807, E826–E949	*52,546*	*23.2*	*2.6*
5	Chronic obstructive pulmonary diseases and allied conditions . . . 490–496	56,050	24.7	2.8
6	Pneumonia and influenza . . . 480–487	54,619	24.1	2.7
7	Diabetes mellitus . . . 250	34,851	15.4	1.7
8	Chronic liver disease and cirrhosis . . . 571	30,583	13.5	1.5
9	Atherosclerosis . . . 440	29,449	13.0	1.5
10	Suicide . . . E950–E959	26,869	11.9	1.5
...	All other causes . . . Residual	303,883	134.1	1.3

[a] Rates per 100,000 population in specified group.
[b] Ninth Revision International Classification of Diseases, 1975.

SOURCE: National Center for Health Statistics, unpublished data.

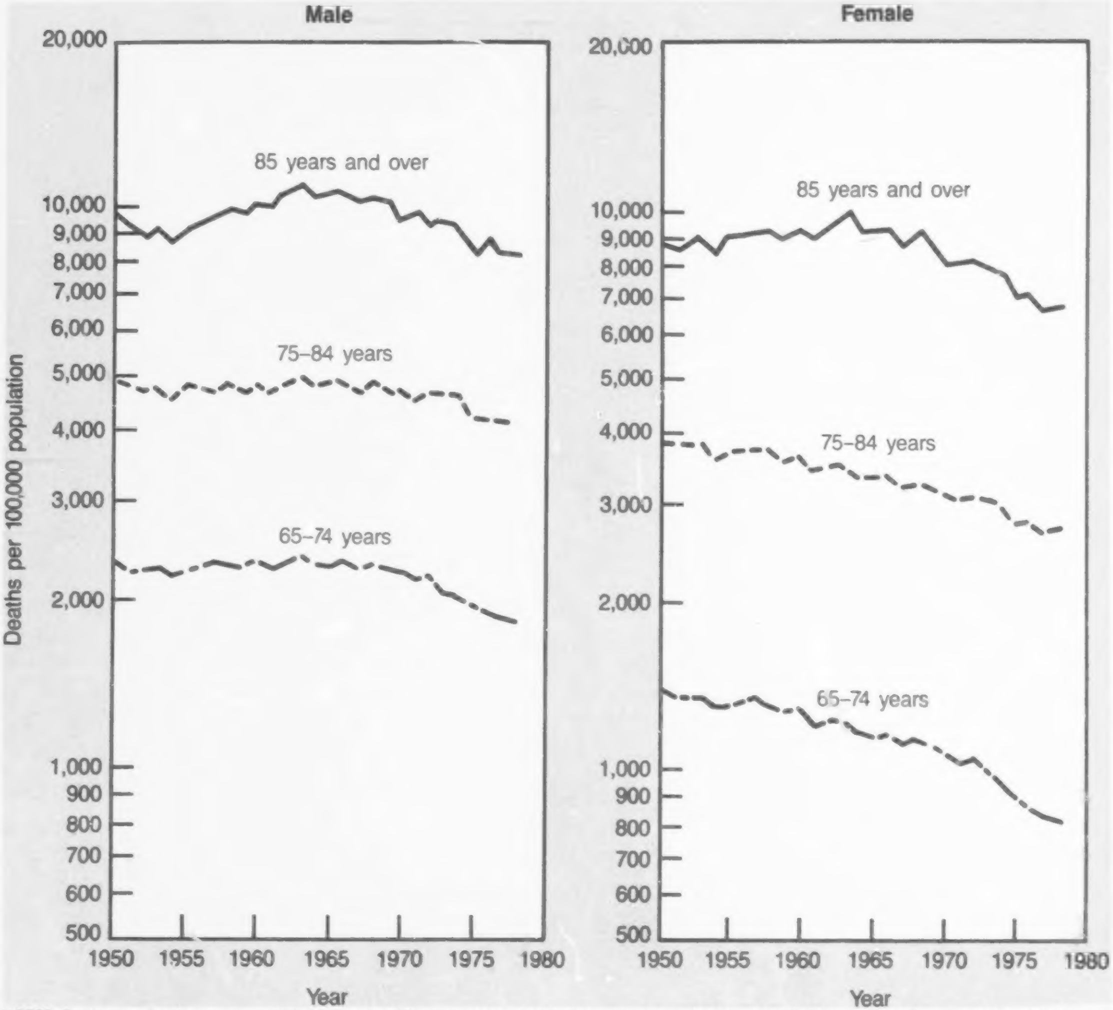
Table A-9.—Deaths and Death Rates[a] Among Persons Aged 65 and Over for the 10 Leading Causes of Death: United States, 1980

Rank order	Cause of death	Number	Rate	Percent of total deaths
	65 years and over			
...	All causes	1,341,848	5,252.0	100%
1	Diseases of heart . . . 390–398, 402, 404–429	595,406	2,330.4	44.4
2	Malignant neoplasms, including neoplasms of lymphatic and hematopoietic tissues . . . 140–208	258,389	1,011.3	19.2
3	Cerebrovascular diseases . . . 430–438	146,417	573.1	10.9
4	Pneumonia and influenza . . . 480–487	45,512	178.1	3.4
5	Chronic obstructive pulmonary diseases and allied conditions . . . 490–496	43,587	170.6	3.2
6	Atherosclerosis . . . 440	28,081	109.9	2.1
7	Diabetes mellitus . . . 250	25,216	98.7	1.9
8	Accidents and adverse effects . . . E800–E949	24,844	97.2	1.8
...	Motor vehicle accidents . . . E810–E825	5,778	22.6	0.4
...	All other accidents and adverse effects . . . E800–E807, E826–E949	19,066	74.6	1.4
9	Nephritis, nephrotic syndrome, and nephrosis . . . 580–589	12,968	50.8	1.0
10	Chronic liver disease and cirrhosis . . . 571	9,519	37.3	0.7
...	All other causes . . . Residual	151,909	594.6	

[a] Rates per 100,000 population in specified group.
[b] Ninth Revision International Classification of Diseases, 1975.

SOURCE: National Center for Health Statistics, Division of Vital Statistics, *Vital Statistics of the United States, Volumell, Mortality* (published and unpublished data).

Figure A-3.—Death Rates Among Persons Aged 65 and Over for Diseases of the Heart, by Sex and Age: United States, 1950-78



NOTES: Death rates for the group aged 85 and over in 1970 are based on population estimates revised by the U.S. Bureau of the Census to correct for overestimates of the group aged 100 and over. ICD codes for 1950-67 are 400-402, and 410-413, and ICDA codes for 1968-78 are 390-398, 402, 404, and 410-429.

SOURCE: U.S. DHHS, NCHS, 1982 (63).

Table A-10.—Death Rates Among Persons Aged 65 and Over for Diseases of the Heart, by Sex and Age: United States, 1950-78

Year	Male			Female		
	65–74 years	75–84 years	85 years and over	65–74 years	75–84 years	85 years and over
	Deaths per 100,000 population					
1950	2,310.1	4,825.0	9,654.4	1,435.0	3,873.0	8,800.0
1951	2,256.6	4,811.1	9,375.4	1,375.4	3,796.1	8,687.8
1952	2,236.2	4,733.5	8,817.9	1,369.1	2,760.9	8,549.9
1953	2,263.2	4,760.6	9,008.7	1,366.2	3,762.2	8,631.3
1954	2,189.3	4,562.6	8,637.2	1,303.5	3,570.8	8,354.8
1955	2,224.8	4,713.5	9,044.7	1,302.2	3,686.4	8,826.9
1956	2,246.0	4,745.7	9,288.4	1,306.4	3,688.6	8,934.7
1957	2,295.1	4,735.6	9,596.4	1,328.3	3,694.3	9,121.9
1958	2,275.9	4,741.3	9,683.4	1,295.0	3,663.6	9,063.2
1959	2,248.9	4,633.1	9,540.6	1,259.6	3,561.5	8,922.5
1960	2,291.3	4,742.4	9,788.9	1,261.3	3,582.7	9,016.8
1961	2,236.9	4,617.7	9,816.4	1,215.6	3,438.0	8,895.1
1962	2,274.3	4,701.3	10,414.7	1,228.8	3,489.6	9,288.0
1963	2,316.3	4,807.5	10,686.2	1,218.6	3,480.4	9,498.1
1964	2,250.3	4,620.4	10,086.8	1,174.9	3,356.7	9,144.6
1965	2,237.6	4,695.5	10,312.1	1,157.2	3,347.2	9,088.2
1966	2,270.8	4,676.8	10,244.5	1,168.8	3,334.1	9,014.6
1967	2,220.7	4,554.9	9,968.3	1,131.0	3,207.3	8,686.6
1968	2,257.5	4,652.6	10,078.0	1,140.9	3,259.2	8,850.1
1969	2,208.2	4,584.0	9,829.2	1,104.0	3,170.4	8,606.4
1970	2,170.3	4,534.8	9,346.0	1,082.7	3,120.8	8.000.9
1971	2,113.1	4,490.7	9,407.2	1,043.9	3,070.8	7,979.3
1972	2,116.3	4,531.8	9,203.8	1,045.4	3,082.1	7,968.6
1973	2,068.2	4,519.5	9,308.6	994.5	3,036.4	7,916.8
1974	1,988.9	4,305.2	8,897.1	948.1	2,903.5	7,537.7
1975	1,886.9	4,156.1	8,171.0	890.8	2,742.4	6,850.9
1976	1,847.6	4,136.1	8,274.9	856.2	2,731.1	6,965.4
1977	1,795.3	4,082.4	8,053.3	831.8	2,662.5	6,655.3
1978	1,761.6	4,064.1	7,990.6	823.1	2,665.6	6,673.5
Percent change, 1950–78	–23.7%	–16.0%	–17.2%	–42.6%	–31.2%	–24.2%

SOURCE: U.S. DHHS, NCHS, 1982 (63).

Table A-11.—Mortality Sex Ratios[a] Among Persons Aged 65 and Over for Diseases of the Heart, by Age: United States, 1950-78

Year	65–74 years	75–84 years	85 years and over
		Ratio	
1950	1.61	1.25	1.10
1951	1.64	1.27	1.08
1952	1.63	1.26	1.03
1953	1.66	1.27	1.04
1954	1.68	1.28	1.03
1955	1.71	1.28	1.02
1956	1.72	1.29	1.04
1957	1.73	1.28	1.05
1958	1.76	1.29	1.07
1959	1.79	1.30	1.07
1960	1.82	1.32	1.09
1961	1.84	1.34	1.10
1962	1.85	1.35	1.12
1963	1.90	1.38	1.13
1964	1.92	1.38	1.10
1965	1.93	1.40	1.13
1966	1.94	1.40	1.14
1967	1.96	1.42	1.15
1968	1.98	1.43	1.14
1969	2.00	1.45	1.14
1970	2.00	1.45	1.17
1971	2.02	1.46	1.18
1972	2.02	1.47	1.16
1973	2.08	1.49	1.18
1974	2.10	1.48	1.18
1975	2.12	1.52	1.19
1976	2.16	1.51	1.19
1977	2.16	1.53	1.21
1978	2.14	1.52	1.20

[a] Ratio of male death rate to female death rate; data derived from table 10.

SOURCE: U.S. DHHS, NCHS, 1982 (63).

en, by contrast, exhibit consistently lower rates in the 65 to 74 age group and consistently higher rates in the 85 and over group than black women. The decline in death rates was generally similar in all sex-race groups except for blacks 75 to 84, of both sexes, among whom the death rate actually rose (table A-12).

Ischemic or coronary heart disease is the major subcategory of heart disease mortality among the elderly; it followed the same patterns of decline, with similar sex and race differences, as heart disease in general from 1968 to 1978 (68). Coronary heart disease mortality may be further subdivided into deaths from chronic coronary disease and acute myocardial infarction (occlusion of a coronary artery resulting in heart attack). Chronic coronary heart disease exhibited a higher death rate than myocardial infarction in all but the 65 to 74 age group (68).

This general decrease in mortality from heart disease is due at least partially to improvements in preventive health practices of the general population that, in combination with medical treatment, can significantly decrease risk factors for heart disease. The major risk factors for heart disease include hypertension, cigarette smoking (24,43), high blood cholesterol, obesity (defined as 20 percent or more above the desirable body weight for a given height, age, and sex), glucose intolerance, lack of exercise (9), and stress (46). Hypertension is the most powerful predictor of heart disease (30) and the accompanying risk actually increases with age. Many of the other risk factors—including blood cholesterol, smoking, and body weight—become less significant in the elderly (8,39) but are known to exacerbate hypertension (see ch. 4).

The prevalence of chronic hypertension rose in the 1970s (see section on "Morbidity") as the death rate for cardiovascular diseases continued to fall. If these prevalence figures are in fact accurate and not artifacts of improved diagnosis and/or statistical reporting, they probably indicate better medical treatment and prevention of hypertension that reduces the associated risk. The same may be true for diabetes, a condition whose prevalence among the elderly also seems

Table A-12.—Death Rates for Diseases of the Heart, by Race, Sex, and Age: United States, Selected Years 1950-80
(data are based on the national vital registration system)

Race, sex, and age	1950[a]	1960[a]	1965[a]	1970	1975	1978	1979	1980[b]	Percent change 1960–79
	Year								
	Number of deaths per 100,000 resident population								
Total[c]									
All ages, age adjusted[d]	307.6	286.2	73.9	253.6	220.5	207.7	203.5	205.3	-28.9%
All ages, crude	355.5	369.0	368.0	362.0	336.2	334.2	333.1	343.0	
65–74 years	1,839.8	1,740.5	1,640.7	1,558.2	1,323.7	1,230.7	1,204.9	1,210.8	-30.8%
75–84 years	4,310.1	4,089.4	3,911.5	3,683.8	3,280.8	3,191.6	3,151.2	3,229.7	-22.9%
85 years and over	9,150.6	9,317.8	9,538.4	8,468.0	7,282.0	7,084.2	6,887.7	7,134.7	-26.1%
White male:									
All ages, age adjusted[d]	381.1	375.4	369.2	347.6	308.0	288.7	281.2	—	-26.2%
All ages, crude	433.0	454.6	450.8	438.3	401.1	390.8	385.7	—	
65–74 years	2,308.3	2,297.9	2,249.0	2,177.2	1,894.6	1,772.7	1,724.9	—	-24.9%
75–84 years	4,907.3	4,839.9	4,792.6	4,617.6	4,237.2	4,122.4	4,040.7	—	-16.5%
85 years and over	9,950.5	10,135.8	10,657.3	9,693.0	8,550.3	8,444.7	8,192.9	—	-19.2%
White female:									
All ages, age adjusted[d]	223.6	197.1	189.9	167.8	144.2	136.4	134.8	—	-31.6%
All ages, crude	289.4	306.5	310.7	313.8	301.3	308.5	311.2	—	
65–74 years	1,400.9	1,229.8	1,128.5	1,044.0	854.9	794.9	781.2	—	-36.5%
75–84 years	3,925.2	3,629.7	3,381.1	3,143.5	2,763.0	2,658.2	2,627.3	—	-27.6%
85 years and over	9.084.7	9,280.8	9,333.2	8,207.5	7,105.3	6,971.6	6,821.0	—	-26.5%
Black male:									
All ages, age adjusted[d]	415.5	381.2	384.1	375.9	328.9	321.0	319.0	—	-16.3%
All ages, crude	348.4	330.6	331.7	330.3	296.1	294.1	293.8	—	
65–74 years	2,140.1	2,281.4	2,185.0	2,237.8	1,918.2	1,744.8	1,723.2	—	-24.5%
75–84 years	4,107.9	3,533.6	3,656.7	3,783.4	3,617.8	3,958.5	4,064.7	—	+15.0%
85 years and over		6,037.9	7,113.3	6,330.8	5,296.2	4,726.2	4,527.1	—	-25.0%
Black female:									
All ages, age adjusted[d]	349.5	292.6	271.1	251.7	209.4	201.1	202.2	—	-30.9%
All ages, crude	289.9	268.5	263.8	261.0	235.7	237.5	239.2	—	
65–74 years	1,659.4	1,680.5	1,513.7	1,553.2	1,309.3	1,136.5	1,136.6	—	-32.4%
75–84 years	3,499.3	2,926.9	2,968.0	2,964.1	2,703.6	3,094.9	3,245.8	—	+10.9%
85 years and over		5,650.0	6,030.4	5,669.8	4,398.0	4,044.6	3,759.3	—	-33.5%

[a] Includes deaths of nonresidents of the United States.

[b] Provisional data.

[c] Includes all races and both sexes.

[d] Age adjusted by the direct method to the total population of the United States as enumerated in 1940, using 11 age groups.

NOTE: For the data years shown, the code numbers for diseases of heart are based on the then current International Classification of Diseases: for 1950, the Sixth Revision, Nos. 400–402, 410–443; for 1960 and 1965, the Seventh Revision, Nos. 400–402, 410–443; for 1970–78, the Eighth Revision, Adapted for Use in the United States, Nos. 390–398, 402, 404, 410–414, 420–429; for 1979 and 1980, the Ninth Revision, Nos. 390–398, 402, 404–429.

SOURCES: National Center for Health Statistics: *Vital Statistics of the United States*, Vol. II, 1950-79. Public Health Service. Washington, DC, U.S. Government Printing Office; Annual summary of births, deaths, marriages, and divorces, United States, 1980. *Monthly Vital Statistics Report*. Vol. 29—No. 13. DHHS Pub. No. (PHS) 81-1120. Public Health Service. Hyattsville, MD, Sept. 17, 1981; Data computed by the Division of Analysis from data compiled by the Division of Vital Statistics; U.S. Bureau of the Census; Population estimates and projections. *Current Population Reports*. Series P-25, Nos. 310, 519, 721, and 870. Washington, DC, U.S. Government Printing Office, June 1965, April 1974, April 1978, and January 1980; *1950 Nonwhite Population by Race*, Special report, P-E No. 3B. Washington, DC, U.S. Government Printing Office, 1951; General population characteristics, United States summary, 1960 and 1970. *U.S. Census of Population*. Final reports PC(1)-1B and PC(1)-B1. Washington, DC, U.S. Government Printing Office, 1961 and 1972.

to be rising; it is not clear, however, that treatment of diabetes reduces the associated risk of cardiovascular mortality.

A higher percentage of elderly men smoke cigarettes than women, which may contribute to the gender difference in heart disease mortality. The percentage of elderly women who smoke, however, has risen dramatically in recent years—a phenomenon that has not yet been reflected in their cardiovascular death rates, probably because the deleterious effects of smoking on the cardiovascular system are only manifested over a period of decades.

Downward trends have also been found in the consumption of cholesterol and saturated fats, high intakes of which have been associated with increased risk of heart disease (15,19,47; see ch. 4). Per capita consumption of foods high in these substances has decreased since the early 1960s, while the consumption of foods high in unsaturated fats and fiber, like fish and vegetables, has increased (70; table A-13). This change in dietary habits may have contributed to the decline in serum cholesterol levels in recent years (1). Diets high in vegetables and low in saturated fats have been shown to reduce blood pressure in normal subjects (41,42).

Table A-13.—Change in Per Capita Consumption of Various Products, 1963-80[a]

Product	Percent Change
Cigarette tobacco	-27.1%
Fluid milk and cream	-24.1
Butter	-33.3
Eggs	-12.3
Animal fats and oils	-38.8
Vegetable fats and oils	+57.6
Fish	+22.6

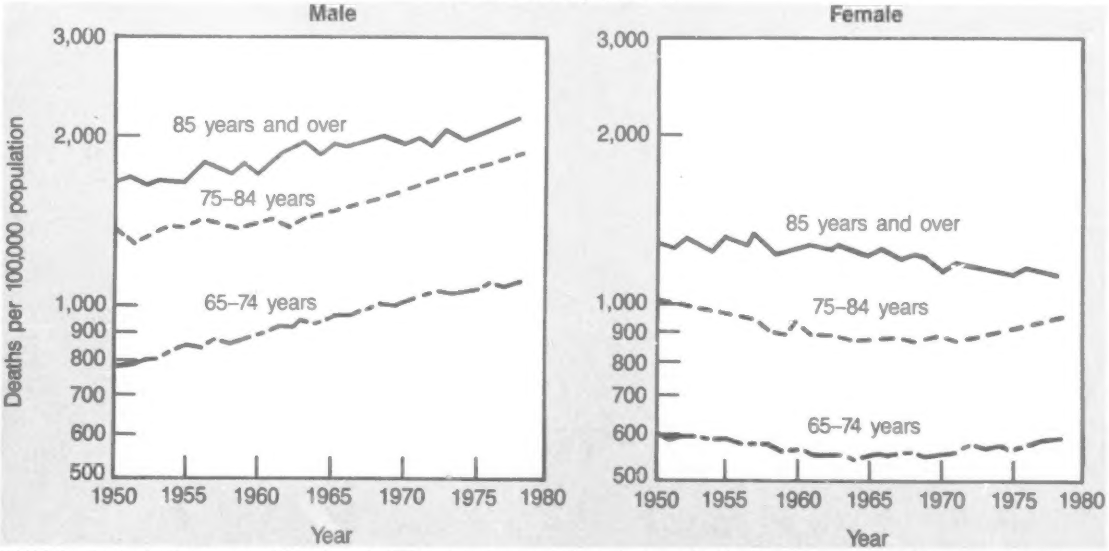
[a] Figures for calculating percentage changes obtained from U.S. Department of Agriculture.

SOURCE: Walker, 1983 (70).

Cancer (Malignant Neoplasms).—Cancer is the second most common cause of death for the general population as well as for elderly people. The incidence[4] and mortality from cancer generally rise with age (fig. A-4)—51 percent of all malignant cancers are diagnosed at ages 65 and over (50,57). In 1980 cancer was the second leading cause of death for persons 65 to 85 and the third (after stroke) for those 85 and over (67). In 1978, cancer accounted for 26 percent of all deaths among those 65 to 74, 18 percent among those 75 to 84, and 10 percent among those 85 and over (63).

Of the top three causes of death, cancer is the only one for which death rates have continued to rise since 1950 (fig. A-5). This trend is due mostly to the dramatic rise in death rates from cancers of the respiratory tract (trachea, bronchus, and lung), among both the elderly and the general population (fig. A-6). All three of these cancers have been linked to cigarette smoking. The death rate due to respiratory cancer among the elderly skyrocketed from 1950 to 1978—a jump

Figure A-4.—Death Rates Among Persons Aged 65 and Over for Malignant Neoplasms, by Sex and Age: United States, 1950-78



NOTES: Death rates for the group aged 85 and over in 1970 are based on population estimates revised by the U.S. Bureau of the Census to correct for overestimates of the group aged 100 and over. ICD codes for 1950-67 are 140-205 and ICDA codes for 1968-78 are 140-209.

SOURCE: U.S. DHHS, NCHS, 1982 (63).

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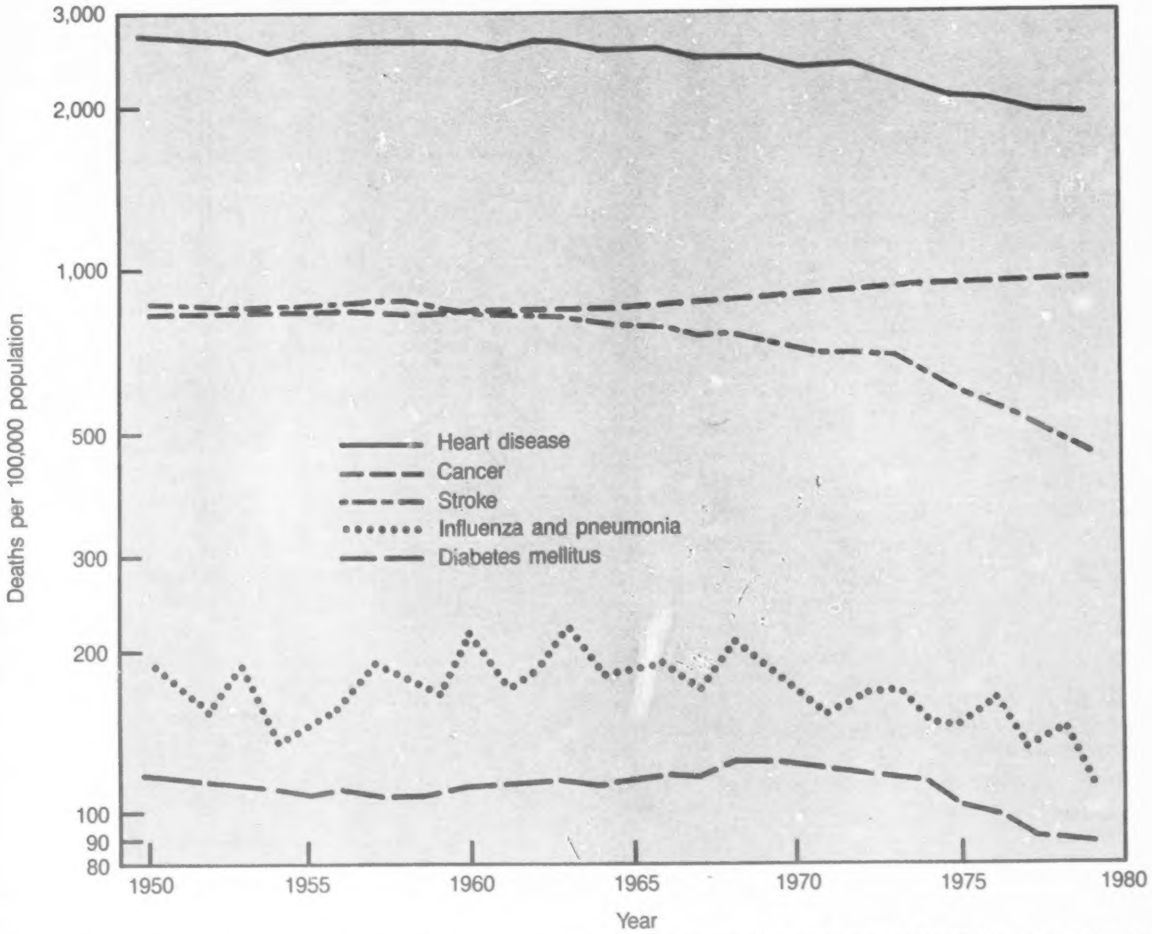
[4] An incidence rate is the estimated number of new cases appearing within a specified time period (which in this report is always 1 year), divided by the total number of individuals within a defined population group.

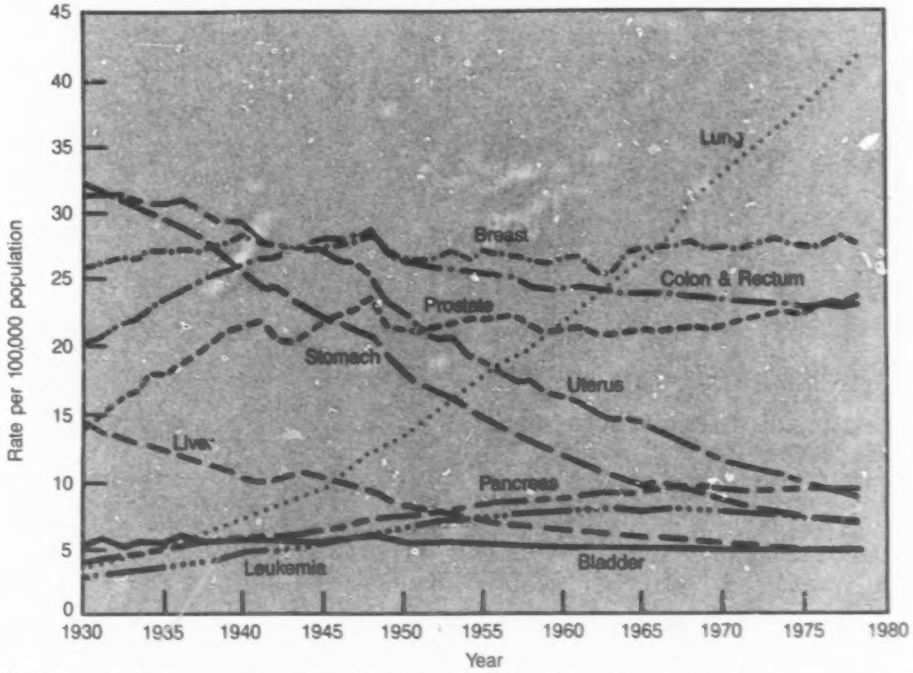
Figure A-5.—Age-Adjusted Death Rates for Persons Aged 65 and Over, by Leading Causes of Death: United States, 1950-79



NOTES: Causes of death are assigned according to the International List of Causes of Death. Because of the decennial revisions and changes in rules for cause-of-death selection, there may be some lack of comparability from one revision to the next. The beginning dates of the revisions are 1949, 1958, 1968, and 1979.

SOURCE: U.S. DHHS, NCHS, 1982 (65).

Figure A-6.—Age-Adjusted Cancer Death Rates by Site: United States, 1930-78



NOTES: Rates for the population are standardized for age based on the 1970 U.S. population. Rates are for both sexes combined, except breast and uterus for female population only and prostate for male population only.

SOURCE: American Cancer Society, 1983 (4).

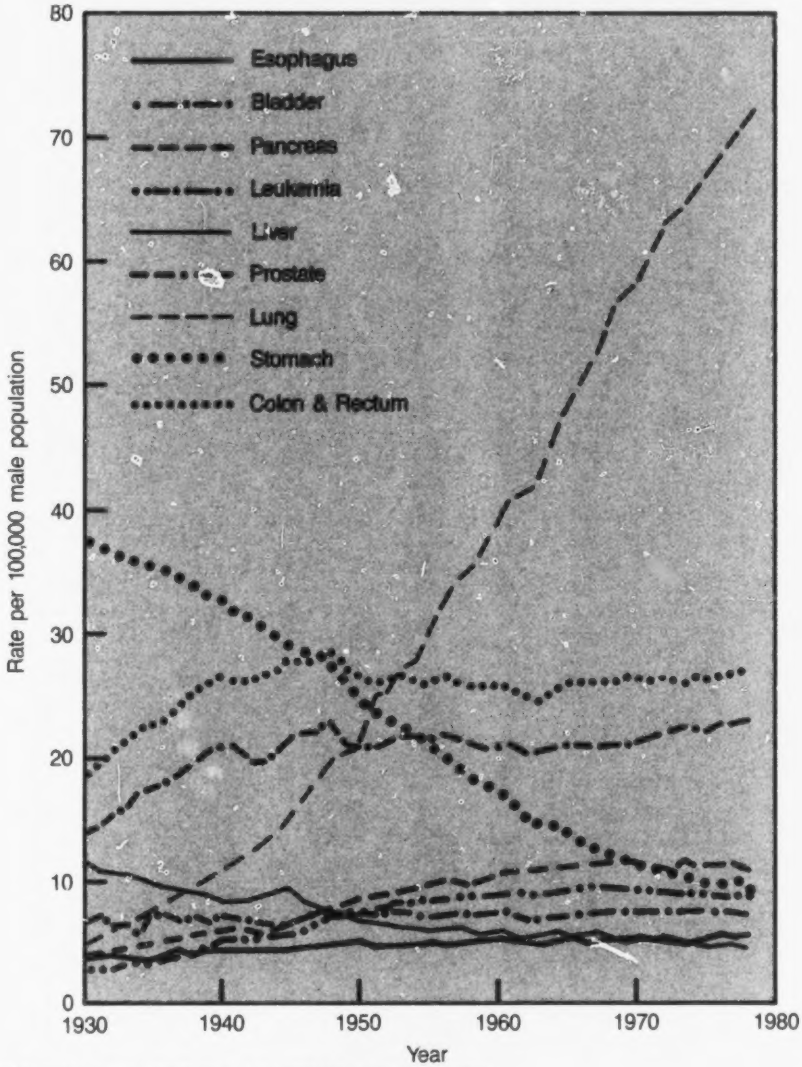
manifested mostly among elderly men (fig. A-7). Cancer mortality is generally higher and has been rising more rapidly in men than in women (fig. A-9, table A-14). This male-female gap has widened over the years, as illustrated by the increasing sex ratios of cancer death rates (table A-15).

Death rates among elderly men for three major types of cancer—respiratory, genital, and colon—have risen notably in the 1950-78 period and are consistently higher for men than for women (tables A-16 through A-18). The incidence rates of respiratory and genital cancer are likewise higher in men (4) (fig. A-8). These cancers accounted for 43 percent of all new cancers in both sexes in the 1970s (50). In 1978, lung cancer was the leading cause of cancer deaths for men 65 to 84, while cancer of the genital organs (mostly prostate) predominated in men over 85 (tables A-16 and A-17). Comparisons of data from two major surveys (49,50) indicate that the incidence of these three cancers, and cancer in general, increased during the 1970s in men; the exact figures are probably not reliable, however, due to differences in sampling procedures and possible changes in diagnostic efficacy over the period.

The overall cancer death rate among elderly women actually fell slightly from 1950 to 1978 (table A-14). Since the mid-1960s, however, the rate has risen for all persons 65 to 84 (fig. A-4). The increase in female cancer mortality is largely due to the sharp rise in respiratory cancer mortality among elderly women over the period (table A-16). Deaths from cancers of the genital organs, breast, and colon fell in most age groups of elderly women (tables A-17 through A-19). The incidence of all four cancers, especially respiratory, has risen during the 1970s (49,50). The simultaneous decline in mortality may be partly due to improved early diagnosis and treatment of these cancers. Breast cancer appears more frequently in women (fig. A-8) but has a relatively low associated death rate.

Table A-20b presents the estimated proportions of cancer deaths attributed to different factors. According to these estimates, tobacco and dietary factors combined account for more than 60 percent of cancer deaths (14). Dietary factors have been implicated

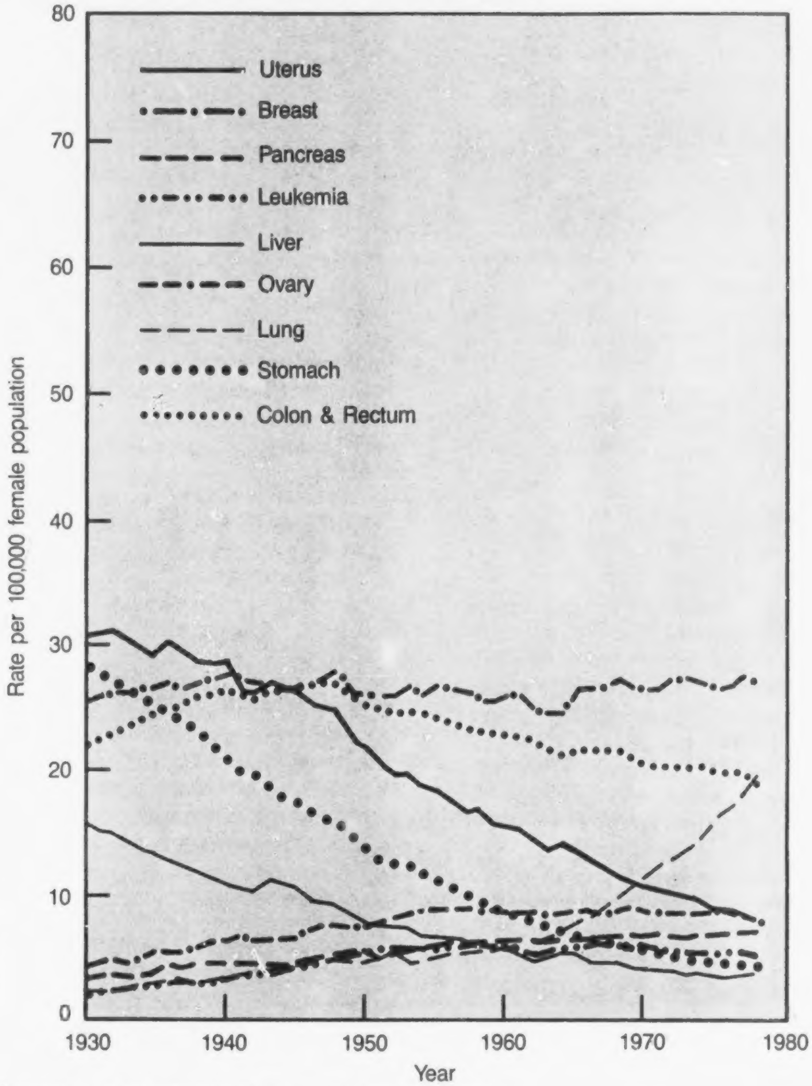
Figure A-7.—Age-Adjusted Cancer Death Rates[a] for Selected Sites, Males: United States, 1930-78



[a]Adjusted to the age distribution of the 1970 U.S. Census Population.

SOURCE: *Cancer Statistics, 1984*, American Cancer Society, 1984 (5).

Figure A-9.—Age-Adjusted Cancer Death Rates[a] for Selected Sites, Females: United States, 1930-78



[a] Adjusted to the age distribution of the 1970 U.S. Census Population.

SOURCE: *Cancer Statistics, 1984*, American Cancer Society, 1984 (5).

Table A-14.—Death Rates Among Persons Aged 65 and Over for Malignant Neoplasms, by Sex and Age: United States, 1950-78

	Male			Female		
Year	65–74 years	75–84 years	85 years and over	65–74 years	75–84 years	85 years and over
	Deaths per 100,000 population					
1950	791.5	1,332.6	1,668.3	612.3	1,000.7	1,299.7
1951	788.5	1,307.3	1,689.1	592.1	987.0	1,284.2
1952	809.1	1,349.2	1,665.6	594.8	990.2	1,304.7
1953	815.0	1,358.9	1,677.9	594.6	986.3	1,296.5
1954	839.4	1,371.6	1,688.8	589.4	972.5	1,275.3
1955	851.0	1,373.9	1,691.0	585.7	962.7	1,303.3
1956	849.3	1,416.6	1,767.9	578.2	957.3	1,286.0
1957	879.3	1,384.5	1,753.4	573.2	945.9	1,309.7
1958	862.5	1,358.6	1,704.9	571.2	919.4	1,268.6
1959	872.8	1,356.4	1,762.8	560.5	903.2	1,241.1
1960	890.5	1,389.4	1,741.2	560.2	924.1	1,263.9
1961	902.4	1,394.8	1,840.8	557.9	891.9	1,273.5
1962	907.7	1,387.2	1,879.7	555.0	885.4	1,264.3
1963	929.8	1,405.2	1,923.9	551.0	881.2	1,280.7
1964	925.9	1,416.6	1,840.3	542.6	868.2	1,238.9
1965	946.1	1,451.6	1,911.1	549.4	874.6	1,234.9
1966	955.4	1,477.9	1,905.4	551.0	872.5	1,252.9
1967	976.8	1,505.2	1,919.0	557.3	867.1	1,215.0
1968	998.2	1,520.1	1,936.1	553.1	860.4	1,223.6
1969	997.3	1,541.1	1,952.9	552.6	871.5	1,202.5
1970	1,006.8	1,588.3	1,908.6	557.9	891.9	1,155.8
1971	1,018.4	1,614.7	1,953.3	557.1	877.1	1,173.2
1972	1,036.1	1,651.7	1,917.4	571.5	878.1	1,174.0
1973	1,003.7	1,665.7	2,018.0	563.7	887.0	1,142.7
1974	1,045.2	1,715.1	1,984.7	566.4	902.0	1,133.9
1975	1,051.8	1,728.4	1,987.4	563.1	910.3	1,128.2
1976	1,060.1	1,782.1	2,042.0	576.0	922.9	1,159.0
1977	1,067.6	1,809.4	2,102.3	581.3	939.1	1,143.5
1978	1,076.7	1,849.4	2,137.2	588.7	958.8	1,139.3
Percent change, 1950–78	+36.0%	+38.8%	+28.1%	−3.8%	−4.2%	−12.3%

SOURCE: U.S. DHHS, NCHS, 1982 (63).

in many cancers of the gastrointestinal tract (see ch. 4). For example, some believe that a diet high in beef and deficient in fiber may contribute to bowel cancer (4).

Smoking is most likely the major contributor to the striking rise in respiratory cancer mortality, and cancer mortality in general, among elderly men and women. Proportionally more elderly men than women smoke, but this gap has narrowed considerably in recent years; the percent of men over 65 who smoke dropped between 1965 and 1980, while that for elderly women rose by 75 percent (table A-20a). The American Cancer Society estimates that cigarette smoking is responsible for 83 percent of lung cancer among men and 43 percent among women, more than 75 percent combined (4). By its estimate, smoking accounts for 25 percent of all cancers and has been linked to conditions ranging from gastric ulcers to chronic bronchitis and emphysema to heart disease.

Industrial and other environmental exposures further compound the hazard: asbestos, for example, in combination with cigarette smoking, increases the cancer risk nearly 60 times (4). This and similar synergistic effects between behavioral and environmental risks illustrate the need for public education about avoidable cancer risks as well as close regulation of carcinogenic hazards in the workplace and the environment in general.

Cerebrovascular Disease (Stroke).—In 1980 stroke was the third leading cause of death among per-

Table A-15.—Mortality Sex Ratios[a] Among Persons Aged 65 and Over for Malignant Neoplasms, by Age: United States, 1950-78

Year	65-74 years	75-84 years	85 years and over
		Ratio	
1950	1.29	1.33	1.28
1951	1.33	1.32	1.32
1952	1.36	1.36	1.28
1953	1.37	1.38	1.29
1954	1.42	1.41	1.32
1955	1.45	1.43	1.30
1956	1.47	1.48	1.37
1957	1.53	1.46	1.34
1958	1.51	1.48	1.34
1959	1.56	1.50	1.42
1960	1.59	1.50	1.38
1961	1.62	1.56	1.45
1962	1.64	1.57	1.49
1963	1.69	1.59	1.50
1964	1.71	1.63	1.49
1965	1.72	1.66	1.55
1966	1.73	1.69	1.52
1967	1.75	1.74	1.58
1968	1.80	1.75	1.58
1969	1.80	1.77	1.62
1970	1.80	1.78	1.65
1971	1.83	1.84	1.66
1972	1.81	1.88	1.63
1973	1.83	1.88	1.77
1974	1.85	1.90	1.75
1975	1.87	1.90	1.76
1976	1.84	1.93	1.76
1977	1.84	1.93	1.84
1978	1.83	1.93	1.88

[a] Ratio of male death rate to female death rate; data derived from table 14.

SOURCE: U.S. DHHS, NCHS, 1982 (63).

sons 65 to 84 and the second among those 85 and over (67). The death rate from stroke increases markedly with age, from 8 percent of all deaths among persons 65 to 74 to 16 percent among those 85 and over (63).

The sex difference for stroke mortality is far smaller than that for either heart disease or cancer, especially in the older age groups. The gap has widened over the years for those 65 to 84, with men in this age group exhibiting consistently higher rates than women since 1950 (see table A-22). In the age group over 85, however, women have had consistently higher rates. Death rates for stroke from blood clots or other occlusions of cerebral arteries slightly lead those for hemorrhagic (bleeding) stroke in both 1970 and 1980 (67,68).

Death rates for stroke among the elderly have decreased more rapidly during the past 30 years than those for heart disease, especially since the mid-1970s when stroke mortality began to fall most steeply (fig. A-10). The decline in stroke mortality, as in heart disease, was generally greater among women than men. The decline for both sexes is smaller in the older age groups (table A-21).

Risk factors for cerebrovascular disease are similar to those for heart disease; again, most of these factors, except for hypertension, are less significant among the elderly. As noted above, hypertension is the most powerful risk factor for stroke (30). The recent decline in mortality due to stroke, and cardiovascular disease in general, is probably due largely to improved acute care, more reliable diagnosis, the reduction of certain risk factors through changes in the dietary habits of the public, and better medical treatment of chronic conditions contributing to the risk (as noted in the section on heart disease).

Other Major Causes of Death.—The death rates of the remaining seven major causes of death among the elderly generally fell during the last four decades (table A-23). Pneumonia and influenza death rates decreased by 55 to 70 percent among the elderly between 1940 and 1980 (less in older age groups), but

Table A-16.—Death Rates Among Persons Aged 65 and Over for Cancer of Trachea, Bronchus, and Lung, by Sex and Age: United States, 1950-78

Year	Male			Female		
	65–74 years	75–84 years	85 years and over	65–74 years	75–84 years	85 years and over
	Deaths per 100,000 population					
1950	98.7	82.6	62.4	23.3	32.9	28.2
1951	108.4	85.3	60.5	22.1	33.6	30.6
1952	117.7	95.6	71.1	24.5	33.8	28.9
1953	127.1	106.2	69.2	23.4	32.8	29.4
1954	139.6	110.5	75.0	22.9	34.5	31.8
1955	148.9	126.9	73.9	23.9	34.1	30.3
1956	163.7	133.3	85.0	24.1	33.9	31.1
1957	173.5	138.8	89.6	24.2	34.3	34.6
1958	181.1	143.2	91.5	24.6	36.0	36.4
1959	192.1	152.2	111.5	24.2	34.4	30.9
1960	204.2	167.1	107.7	24.4	32.8	38.8
1961	217.1	176.2	128.7	25.6	35.8	39.4
1962	228.1	191.4	126.2	25.6	35.6	40.1
1963	240.2	205.9	142.7	27.3	35.0	43.2
1964	247.0	218.6	135.6	27.7	38.2	38.7
1965	261.8	231.7	155.0	30.4	36.6	43.7
1966	272.6	254.2	156.0	31.7	40.9	50.7
1967	284.7	278.1	173.7	34.2	41.9	43.8
1968	305.5	292.9	193.6	39.1	49.7	55.3
1969	312.8	303.3	205.2	42.1	47.5	51.3
1970	320.8	330.8	215.1	43.1	52.4	52.7
1971	334.5	357.1	236.6	48.6	55.0	58.7
1972	345.4	373.3	228.4	53.0	56.4	57.4
1973	350.3	381.5	252.5	55.0	60.5	58.4
1974	354.4	407.2	262.0	60.2	64.2	63.2
1975	365.4	417.9	267.4	64.5	66.8	65.7
1976	371.8	443.0	289.7	71.7	74.9	69.3
1977	382.4	467.8	305.3	76.7	78.6	70.1
1978	389.0	478.6	317.4	84.9	87.1	70.0
Percent change, 1950–78	+291.4%	+479.4%	+508.6%	+264.4%	+164.7%	−148.2%

SOURCE: U.S. DHHS, NCHS, 1982 (63).

remain the fourth leading killers among the elderly. Tuberculosis, the second leading killer in the general population in 1900, has declined by at least 80 percent among the elderly since 1940 and is no longer a major cause of death in the United States. Vaccination, improved public sanitation, and improved acute care account for most of the decline in such infectious diseases.

The fifth and tenth leading causes of death among the elderly, chronic obstructive pulmonary (lung) disease (including bronchitis, emphysema, and asthma) and chronic liver disease (including cirrhosis) have both increased in some age groups in recent years (table A-23). Death rates were much higher for elderly men than women for both diseases; they were four to eight times higher for chronic obstructive lung disease. This is due in part to the higher percentage of men who smoke, a risk factor for both diseases (64), and to the generally higher proportion of heavy drinkers among men, a risk factor for cirrhosis (65). The death rate for obstructive pulmonary disease increases with age and has risen more in the older age groups since 1970 (more than twofold for those over 85; see table A-23). Chronic liver disease mortality rose in both the general population and among the population 65 to 74.

Mortality due to arteriosclerosis, currently the sixth leading cause of death among the elderly, fell by at least 60 percent between 1950 and 1980, with smaller declines in older age groups. Mortality due to hypertension similarly fell by at least 67 percent during the same period—elderly women exhibited lower rates than men for both conditions (table A-23).

Death rates for diabetes mellitus (currently ranked seventh among the elderly) have generally fallen since 1940 except in the 85 and over group, for which the

Table A-17.—Death Rates Among Persons Aged 65 and Over for Cancer of Genital Organs, by Sex and Age: United States, 1950-78

Year	Male			Female		
	65–74 years	75–84 years	85 years and over	65–74 years	75–84 years	85 years and over
	Deaths per 100,000 population					
1950	103.9	281.4	436.2	110.1	136.9	141.4
1951	100.6	286.5	421.9	105.7	132.3	132.8
1952	103.5	290.2	464.5	106.0	132.6	133.3
1953	105.7	296.9	451.9	105.8	131.0	134.8
1954	106.1	305.5	464.1	102.5	132.0	128.9
1955	106.4	296.2	465.7	103.0	126.5	136.3
1956	105.3	309.1	488.4	99.3	124.1	137.4
1957	103.4	299.8	479.2	99.8	118.9	135.2
1958	104.3	286.9	470.1	100.3	123.0	138.6
1959	102.0	278.5	467.9	98.4	119.2	133.7
1960	102.1	285.9	468.2	97.9	119.1	131.4
1961	101.3	286.1	508.4	98.4	112.9	123.0
1962	102.3	284.8	505.6	95.0	114.1	129.1
1963	104.6	282.4	514.9	93.4	115.0	128.4
1964	103.0	282.4	497.4	91.6	112.9	123.3
1965	100.4	286.6	513.3	92.7	108.9	124.3
1966	101.3	283.6	507.1	91.7	110.4	128.1
1967	102.4	286.4	513.6	90.2	104.5	118.6
1968	105.8	285.1	512.3	86.0	107.7	120.4
1969	102.9	288.5	493.2	84.5	105.7	121.1
1970	103.7	299.4	481.6	85.6	104.9	113.1
1971	103.2	297.9	493.8	83.3	105.0	116.8
1972	106.1	300.8	489.0	83.5	104.9	114.3
1973	105.5	309.3	514.3	79.4	103.3	108.4
1974	106.9	310.5	439.9	77.7	102.2	110.5
1975	105.4	312.4	494.9	77.4	102.5	108.7
1976	106.4	321.4	514.6	77.5	108.7	106.4
1977	105.4	322.1	527.0	75.3	102.8	104.4
1978	107.1	331.6	548.7	74.7	100.8	103.6
Percent change, 1950–78	+3.1%	+13.8%	+25.8%	−32.2%	−26.4%	−26.7%

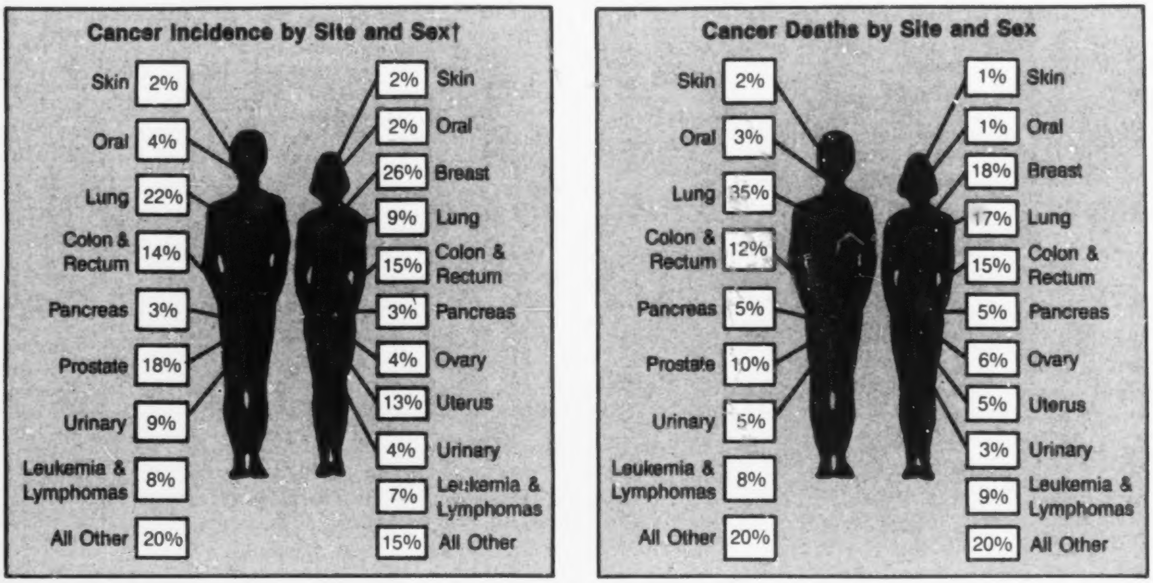
SOURCE: U.S. DHHS, NCHS, 1982 (63).

Table A-18.—Death Rates Among Persons Aged 65 and Over for Cancer of Colon, by Sex and Age: United States, 1950-78

Year	Male 65–74 years	Male 75–84 years	Male 85 years and over	Female 65–74 years	Female 75–84 years	Female 85 years and over
	Deaths per 100,000 population					
1950	84.9	155.0	181.0	86.1	171.6	240.0
1951	85.6	151.1	194.9	83.3	168.8	230.8
1952	87.1	159.1	178.8	82.0	165.9	231.0
1953	85.0	158.1	191.3	81.8	163.7	241.0
1954	84.2	158.4	179.9	83.7	164.2	240.9
1955	85.9	158.4	202.8	83.9	162.5	245.9
1956	87.5	169.1	200.6	81.9	161.4	227.4
1957	89.4	162.7	209.2	81.6	159.6	243.5
1958	87.4	160.2	205.4	81.2	155.2	250.2
1959	87.5	160.9	214.6	79.8	159.4	231.1
1960	86.7	164.0	205.6	79.6	159.6	232.6
1961	89.6	165.3	215.8	79.6	157.9	235.8
1962	88.3	159.0	242.8	81.8	153.4	233.9
1963	90.5	162.3	224.1	80.1	155.8	242.6
1964	88.7	170.6	215.0	80.5	152.2	230.0
1965	93.2	172.5	242.5	80.1	150.0	227.0
1966	93.8	175.4	227.6	81.2	151.2	244.0
1967	94.0	172.2	237.1	79.5	152.5	223.3
1968	95.2	177.7	229.5	79.4	149.7	235.3
1969	95.6	181.8	245.8	77.4	153.3	229.8
1970	95.7	184.8	244.4	81.0	157.4	224.8
1971	97.0	183.8	236.6	78.0	151.5	224.1
1972	95.8	194.2	235.2	80.7	150.3	229.7
1973	96.0	188.5	252.3	78.5	159.3	214.2
1974	100.8	197.4	267.6	79.9	156.9	224.9
1975	99.1	200.1	241.9	77.0	158.9	211.6
1976	102.6	207.5	260.7	79.8	159.0	229.6
1977	104.5	202.8	273.9	77.6	162.5	221.8
1978	104.9	214.3	282.1	80.4	167.1	228.5
Percent change, 1950–78	+23.6%	+38.2%	+55.8%	–6.6%	–2.6%	–4.8%

SOURCE: U.S. DHHS, NCHS, 1982 (63).

Figure A-8.—Cancer Incidence and Deaths, by Site and by Sex: United States, 1983 (percent distribution)



†Excluding non-melanoma skin cancer and carcinoma in situ.

SOURCE: American Cancer Society, 1983 (4).

rate has almost doubled (table A-23). The reason for this age-specific upturn is unclear, but the trend could become increasingly important if, as projected, the over-85 group grows proportionally larger in the future.

Mortality due to accidents of all kinds is ranked eighth among those over 65, but fell substantially from 1950 to 1980 with a smaller drop in the "motor vehicle accidents" category. Among older women, mortality from accidents was higher only in the 85 and over group. Nephritis, the sixth leading cause of death among the general population in 1900, now ranks ninth among the elderly. The percent drop shown in table A-23 is probably not reliable, however, because the statistical description of the disease has changed.

Morbidity

TRENDS IN CHRONIC CONDITIONS CAUSING DISABILITY

The prevalence of chronic disease is expected to increase as the population ages (18; see chs. 2 and 3). Effective prevention and treatment of acute illness at earlier ages have been key factors in helping people to live longer. People who would once have died of tuberculosis or other infectious diseases in their twenties, for example, now live to develop chronic illnesses whose risk and prevalence tend to rise with age. Advancing age also brings increased risk of certain acute medical episodes (e.g., stroke, heart attack, and pneumonia) that may also add to the burden of morbidity among the elderly through their deleterious aftereffects (e.g., dementia, paralysis, chronic heart disease, and chronic obstructive lung disease).

Chronic disease is responsible for more than 80 percent of all disability (69) and usurps 80 percent of all health care resources in the United States (13). An estimated 86 percent, or six of every seven, elderly people have one or more chronic conditions, compared to less than 50 percent of the general population (21,44,51). Most significantly, the proportion of those with chronic conditions who suffer major disability is much higher among the elderly: only 4 percent of the general population afflicted with chronic illness reported limitation in a major activity (i.e., working, keeping house, or engaging in educational activities) compared to 18 percent in the over-65 group. About 47 percent of community-dwelling elderly exhibit some degree of activity limitation due to chronic conditions (see ch. 2). All of the chronic conditions discussed in this appendix are relatively more prevalent among the elderly and can cause significant functional

Table A-19.—Death Rates Among Females Aged 65 and Over for Cancer of Breast, by Age: United States, 1950-78

Year	65–74 years	75–84 years	85 years and over
	Deaths per 100,000 females		
1950	95.0	139.8	195.5
1951	91.1	143.6	196.7
1952	91.2	133.9	184.8
1953	93.6	140.5	198.8
1954	93.2	136.4	193.9
1955	92.8	141.3	198.2
1956	93.6	136.3	199.1
1957	93.0	136.0	199.8
1958	90.4	129.5	182.8
1959	89.2	125.9	191.3
1960	90.0	129.9	191.9
1961	90.3	130.6	194.9
1962	90.5	125.5	188.2
1963	90.1	119.2	183.3
1964	89.3	120.3	188.4
1965	90.2	126.8	181.4
1966	90.2	122.7	177.3
1967	90.9	122.6	181.7
1968	94.3	124.1	179.4
1969	93.0	120.1	170.2
1970	93.8	127.4	165.6
1971	92.9	125.2	170.4
1972	98.1	125.4	169.9
1973	101.1	128.1	169.4
1974	97.5	130.3	168.9
1975	97.0	130.7	160.0
1976	98.9	130.5	163.8
1977	102.2	135.3	169.4
1978	98.9	133.1	157.2
Percent change, 1950–78	+4.1%	–4.8%	–19.6%

SOURCE: U.S. DHHS, NCHS, 1982 (63).

Table A-20b.—Proportions of Cancer Deaths Attributed to Various Factors

Text section number	Factor or class of factors	Percentage of all cancer deaths: Best estimate	Percentage of all cancer deaths: Range of acceptable estimates
5.1	Tobacco	30	25–40
5.2	Alcohol	3	2–4
5.3	Diet	35	10–70
5.4	Food additives	<1	–5[a]–2
5.5	Reproductive and sexual behavior	7	1–13
5.6	Occupation	4	2–8
5.7	Pollution	2	<1–5
5.8	Industrial products	<1	<1–2
5.9	Medicines and medical procedures	1	0.5–3
5.10	Geophysical factors	3	2–4
5.11	Infection	10 ?	1–?
5.12	Unknown	?	?

[a] Allowing for a possibly protective effect of antioxidants and other preservatives.

SOURCE: Doll and Peto, 1981 (14).

Table A-20a.—Cigarette Smoking Status of Persons Aged 20 and Over, by Sex, Race, and Age: United States, 1965, 1976, and 1980

	Smoking status					
	Current smoker[a]			Former smoker		
Sex, race, and age	1965	1976	1980[b]	1965	1976	1980[b]
MALE	Percent of persons					
Total[c,d]						
All ages, 20 years and over	52.4%	41.9%	38.3%	20.5%	28.9%	29.3%
20–24 years	59.2	45.9	39.7	9.0	12.2	12.1
25–34 years	60.7	48.5	43.1	14.7	18.3	20.6
35–44 years	58.2	47.6	42.6	20.6	27.3	27.6
45–64 years	51.9	41.3	40.8	24.1	37.1	36.9
65 years and over	28.5	23.0	17.9	28.1	44.4	47.4
White:						
All ages, 20 years and over	51.5	41.2	37.4	21.4	30.0	30.9
20–24 years	58.1	45.3	39.0	9.6	13.3	12.2
25–34 years	60.1	47.7	42.0	15.5	18.9	21.9
35–44 years	57.3	46.8	42.4	21.5	28.9	28.8
45–64 years	51.3	40.6	40.0	25.1	38.1	38.4
65 years and over	27.7	22.8	16.6	28.7	45.6	50.1
Black:						
All ages, 20 years and over	60.8	50.5	45.6	12.1	19.3	19.1
20–24 years	67.4	52.8	45.5	3.8	4.1	10.6
25–34 years	68.4	59.4	52.0	6.7	11.8	11.9
35–44 years	67.3	58.8	44.2	12.3	13.8	21.2
45–64 years	57.9	49.7	48.8	15.3	28.6	26.3
65 years and over	36.4	26.4	27.9	21.5	33.0	26.6
FEMALE						
Total[c,d]						
All ages, 20 years and over	34.1	32.0	29.4	8.2	13.8	15.5
20–24 years	41.9	34.2	32.7	7.3	10.4	11.0
25–34 years	43.7	37.5	31.6	9.9	12.9	14.4
35–44 years	43.7	38.2	34.9	9.6	15.8	18.9
45–64 years	32.0	34.8	30.8	8.6	15.9	17.1
65 years and over	9.6	12.8	16.8	4.5	11.7	14.2
White:						
All ages, 20 years and over	34.2	31.8	29.5	8.5	14.4	16.0
20–24 years	41.9	34.4	33.3	8.0	11.4	12.5
25–34 years	43.4	37.1	31.6	10.3	13.7	14.7
35–44 years	43.9	38.1	35.6	9.9	17.0	20.2
45–64 years	32.7	34.7	30.6	8.8	16.4	17.4
65 years and over	9.8	13.2	17.4	4.5	11.5	14.3
Black:						
All ages, 20 years and over	34.4	35.1	30.8	6.0	9.9	11.2
20–24 years	44.2	34.9	32.3	2.5	5.0	2.2
25–34 years	47.8	42.5	34.2	6.7	8.9	11.6
35–44 years	42.8	41.3	36.5	7.0	9.6	12.5
45–64 years	25.7	38.1	34.3	6.6	11.9	14.1
65 years and over	7.1	9.2	9.4	4.5	13.3	14.1

[a] A current smoker is a person who has smoked at least 100 cigarettes and who now smokes; includes occasional smokers.
[b] Based on data for the last 6 months of 1980.
[c] Base of percent excludes persons with unknown smoking status.
[d] Includes all other races not shown separately.

NOTE: Data are based on household interviews of a sample of the civilian noninstitutionalized population.

SOURCE: U.S. DHHS, NCHS, 1982 (65).

Table A-22.—Mortality Sex Ratios[a] Among Persons Aged 65 and Over for Cerebrovascular Diseases, by Age: United States, 1950-78

Year	65–74 years	75–84 years	85 years and over
	Ratio		
1950	1.13	1.06	1.03
1951	1.16	1.04	0.96
1952	1.15	1.07	0.95
1953	1.16	1.06	0.93
1954	1.19	1.07	0.91
1955	1.20	1.07	0.95
1956	1.21	1.07	0.94
1957	1.22	1.08	0.95
1958	1.24	1.07	0.93
1959	1.24	1.07	0.96
1960	1.28	1.08	0.98
1961	1.26	1.09	0.98
1962	1.28	1.10	0.98
1963	1.29	1.10	0.99
1964	1.29	1.12	0.99
1965	1.33	1.12	0.99
1966	1.32	1.13	0.98
1967	1.36	1.15	1.00
1968	1.37	1.14	0.99
1969	1.37	1.15	0.98
1970	1.35	1.15	0.99
1971	1.40	1.18	0.99
1972	1.41	1.17	0.99
1973	1.41	1.15	0.97
1974	1.41	1.15	0.99
1975	1.41	1.16	1.00
1976	1.41	1.14	0.99
1977	1.40	1.16	0.99
1978	1.39	1.14	0.98

[a] Ratio of male death rate to female death rate.

SOURCE: U.S. DHHS, NCHS, 1982 (63).

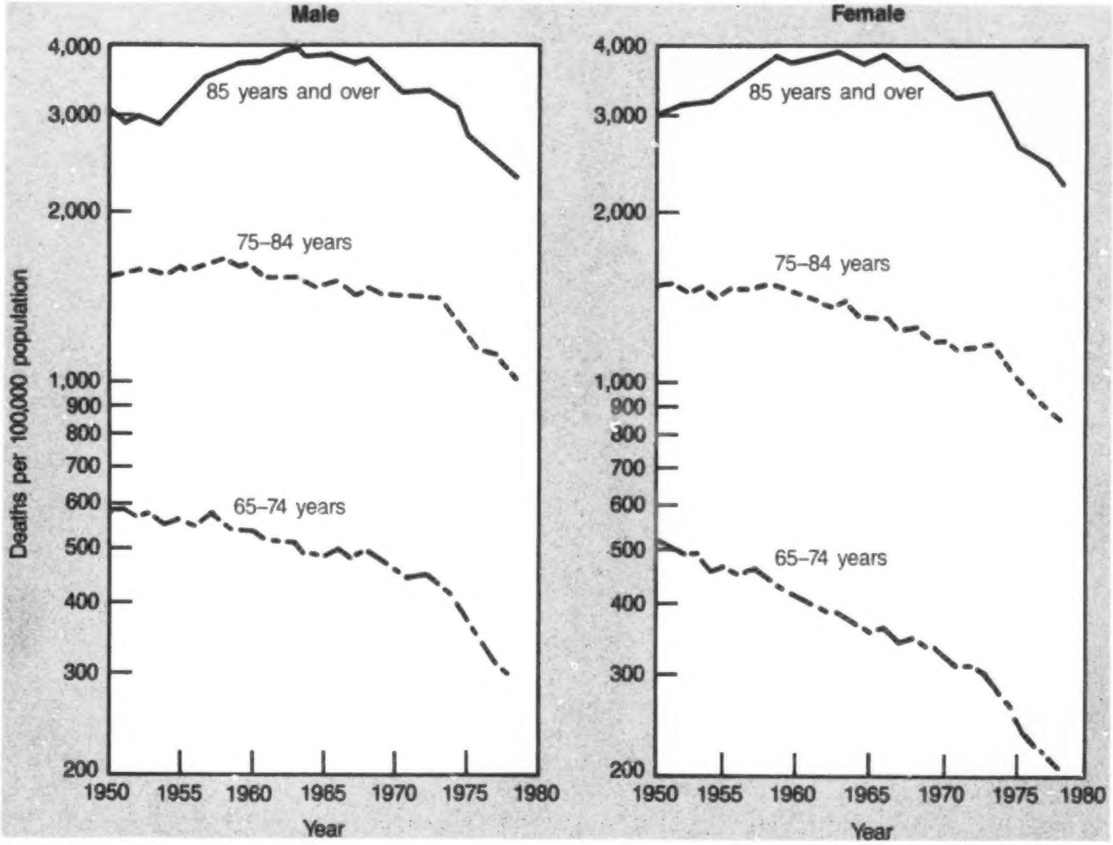
disability (the types and degree of disability inflicted by specific chronic conditions are discussed in ch. 7).

The proportion of people with multiple diseases rises rapidly with age. Surveys of the noninstitutionalized elderly report an average of three chronic conditions per person (51,71). Other estimates are as high as five per person, doubling for institutionalized elderly, and rising to more than a dozen in the very old (6). Table A-24 lists the problems commonly coexisting in the elderly.

This frequent multiplicity of disorders combines with and exacerbates the tendency of diseases to present different symptoms in the elderly than in younger people, rendering diagnosis difficult. The classic symptoms are often replaced by one or more nonspecific problems that may be wrongly attributed to "aging" in general (7; table A-25). This diagnostic difficulty has implications for the accuracy of survey data and, most importantly, for health care delivery. Improved detection, diagnosis, and statistical reporting of certain conditions has led to greater awareness of the multiplicity of chronic diseases among the elderly.

Unfortunately, most of the trend analyses of prevalence in this appendix are limited to the period of the eighth revision of the ICD (1968-78) since there are no comparability ratios for chronic conditions. In addition, NCHS data began to be collected annually only in 1978, are not subdivided into age and sex groups for the elderly, and represent only the civilian, noninstitutionalized population. Sporadic reports focusing on one of the six categories of conditions—circulatory, respiratory, digestive, skin and musculoskeletal, other chronic conditions, and selected impairments—are used where possible. Because the prevalence of most of these conditions is higher among the institutionalized elderly, who are not represented here, and since methodological studies show that chronic conditions are generally underreported in interview surveys (especially those with stigma attached), the given rates are very likely to be underestimates.

Figure A-10.—Death Rates Among Persons Aged 65 and Over for Cerebrovascular Diseases, by Sex and Age: United States, 1950-78



NOTES: Death rates for the group aged 85 and over in 1970 are based on population estimates revised by the U.S. Bureau of the Census to correct for overestimates of the group aged 100 and over. ICD codes for 1950-67 are 330-334, and ICDA codes for 1968-78 are 430-438.

SOURCE: U.S. DHHS, NCHS, 1982 (63).

Table A-21.—Death Rates Among Persons Aged 65 and Over for Cerebrovascular Diseases, by Sex and Age: United States, 1950-78

	Male			Female		
Year	65–74 years	75–84 years	85 years and over	65–74 years	75–84 years	85 years and over
	Deaths per 100,000 population					
1950	589.6	1,543.6	3,048.6	522.1	1,462.2	2,949.4
1951	593.7	1,546.0	2,925.8	511.1	1,490.8	3,047.8
1952	572.8	1,559.1	2,965.9	499.9	1,451.7	3,127.6
1953	573.2	1,552.7	2,918.3	493.1	1,461.6	3,147.3
1954	550.9	1,514.9	2,887.2	461.2	1,414.6	3,179.1
1955	554.7	1,553.1	3,185.5	462.1	1,452.8	3,365.0
1956	548.1	1,547.5	3,257.8	452.4	1,443.6	2,480.9
1957	561.8	1,594.1	3,474.5	460.5	1,470.9	3,655.3
1958	552.4	1,601.0	3,529.1	444.4	1,490.7	3,775.4
1959	534.1	1,566.7	3,558.0	429.7	1,462.9	3,695.0
1960	530.7	1,555.9	3,643.1	415.7	1,441.1	3,704.4
1961	503.6	1,495.9	3,659.2	400.0	1,375.9	3,746.8
1962	502.4	1,493.2	3,771.4	393.3	1,359.6	3,844.2
1963	500.4	1,497.1	3,803.2	389.3	1,365.2	3,824.4
1964	481.4	1,448.8	3,638.5	372.5	1,295.5	3,673.8
1965	480.9	1,439.0	3,693.7	362.6	1,284.3	3,731.4
1966	482.2	1,445.1	3,663.8	364.3	1,281.7	3,740.4
1967	468.1	1,398.4	3,548.6	343.7	1,219.0	3,550.4
1968	483.1	1,418.2	3,591.6	351.6	1,248.8	3,618.3
1969	465.7	1,373.9	3,396.1	339.8	1,190.1	3,450.0
1970	449.5	1,361.6	3,211.2	333.3	1,183.1	3,247.0
1971	438.9	1,358.9	3,167.5	313.5	1,151.1	3,204.0
1972	439.3	1,356.2	3,188.6	312.1	1,162.3	3,212.4
1973	425.0	1,338.5	3,133.8	301.3	1,167.6	3,230.1
1974	400.4	1,277.2	2,969.5	283.7	1,114.0	3,013.0
1975	363.1	1,176.7	2,650.9	256.9	1,014.5	2,656.6
1976	334.7	1,098.9	2,574.4	238.1	962.1	2,592.6
1977	310.4	1,060.0	2,402.4	221.0	916.5	2,435.6
1978	290.0	984.5	2,244.2	207.9	865.5	2,298.5
Percent change, 1950–78	–50.8%	–36.2%	–26.4%	–60.2%	–40.8%	–22.1%

SOURCE: U.S. DHHS, NCHS, 1982 (63).

Table A-23.—Death Rates for Major Causes of Death, by Sex and Age: United States, 1940-80[a]

Cause of death	1940		1950		1960		1970		1980	Percent change 1940–80
	Male	Female	Male	Female	Male	Female	Male	Female	Both sexes	Both sexes[b]
Major cardiovascular disease:										
All ages	5.4	4.3	5.8	4.4	5.9	4.5	5.5	4.4	4.4	-10%
65–74	32.6	24.9	31.3	21.2	30.3	18.0	27.8	14.9	15.1	-47
75–84	78.9	68.4	71.6	59.8	69.2	55.0	63.6	46.1	40.2	-41
85+	161.2	148.4	154.0	140.8	154.9	146.0	126.0	118.6	109.5	-29
Hypertensive disease[c]:										
All ages	—	—	0.8	0.8	0.7	0.7	0.4	0.4	0.3	-60
65–74	—	—	0.4	0.3	0.3	0.2	0.2	0.1	0.1	-67
75–84	—	—	1.1	1.1	0.9	0.8	0.5	0.3	0.3	-73
85+	—	—	3.0	2.7	2.5	2.2	1.2	0.9	0.9	-68
Diabetes:										
All ages	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.1	-50
65–74	0.8	1.3	0.8	1.2	0.8	1.1	0.8	1.0	0.6	-40
75–84	1.3	1.6	1.4	1.9	1.4	1.8	1.7	2.0	1.3	-13
85+	1.2	1.2	1.4	1.6	1.7	1.9	2.2	2.4	2.2	+83
Nephritis[c]:										
All ages	1.4	1.2	0.2	0.2	0.5	0.5	0.5	0.7	0.7	+95
65–74	8.9	7.3	0.8	0.6	0.3	0.2	0.3	0.2	0.2	-98
75–84	24.2	19.5	2.0	1.5	0.5	0.3	0.7	0.3	0.7	-97
85+	51.5	40.6	4.7	3.7	1.4	1.1	1.4	0.9	1.7	-96
Influenza and pneumonia:										
All ages	0.8	0.6	0.3	0.3	0.4	0.3	0.4	0.3	0.2	-71
65–74	2.5	2.0	1.2	0.8	1.5	0.8	1.3	0.6	0.6	-74
75–84	7.2	6.6	3.3	2.7	4.2	2.8	3.8	2.0	2.2	-68
85+	20.4	19.4	10.3	9.0	12.7	10.4	9.6	17.3	8.9	-55
Tuberculosis:										
All ages	0.5	0.4	0.3	0.2	0.9	0.3	0.3	0.1	0.1	-93
65–74	1.1	0.6	0.9	0.3	0.4	0.9	0.15	0.4	0.3	-97
75–84	0.9	0.7	0.9	0.4	0.5	0.2	0.2	0.6	0.6	-92
85+	0.7	0.6	0.7	0.3	0.6	0.2	0.3	0.8	0.1	-80
Cirrhosis of the liver:										
All ages	0.8	0.5	0.1	0.6	0.1	0.8	0.2	0.1	0.1	+43
65–74	0.4	0.2	0.5	0.2	0.6	0.2	0.7	0.2	0.4	+33
75–84	0.6	0.3	0.5	0.3	0.5	0.2	0.5	0.2	0.3	-25
85+	0.5	0.5	0.4	0.4	0.4	0.2	0.3	0.1	0.2	-60
Chronic obstructive pulmonary diseases[d]:										
All ages	—	—	—	—	—	—	0.2	0.6	0.2	—
65–74	—	—	—	—	—	—	1.6	0.2	1.3	+44
75–84	—	—	—	—	—	—	2.7	0.4	2.2	+70
85+	—	—	—	—	—	—	2.4	0.6	2.7	+125
Arteriosclerosis[e]:										
All ages	—	—	0.2	0.2	0.2	0.2	0.1	0.2	0.1	-50
65–74	—	—	0.8	0.6	0.7	0.5	0.6	0.3	0.2	-71
75–84	—	—	4.4	3.5	3.4	2.8	2.3	1.8	1.2	-69
85+	—	—	18.6	16.4	14.5	14.0	8.7	8.9	6.6	-62

Table A-23.—Death Rates for Major Causes of Death, by Sex and Age: United States, 1940-80[a]—continued

	1940		1950		1960		1970		1980	Percent change 1940–80
Cause of death	Male	Female	Male	Female	Male	Female	Male	Female	Both sexes	Both sexes[b]
Accidents (all kinds)[e]:										
All ages	—	—	0.8	0.4	0.7	0.3	0.8	0.3	0.5	-17%
65–74	—	—	1.5	0.8	1.2	0.6	1.2	0.6	0.6	-50
75–84	—	—	3.2	3.1	2.4	2.0	2.2	1.4	1.2	-62
85+	—	—	8.2	10.8	5.8	6.5	4.3	3.7	2.9	-70
Motor vehicle accidents[e]:										
All ages	—	—	0.4	0.1	0.3	0.1	0.4	0.1	0.2	—
65–74	—	—	0.6	0.2	0.5	0.2	0.5	0.2	0.2	-50
75–84	—	—	0.8	0.2	0.7	0.2	0.7	0.3	0.3	-40
85+	—	—	0.8	0.2	0.6	0.2	0.6	0.2	0.3	-25
All other accidents[e]:										
All ages	—	—	0.5	0.3	0.4	0.2	0.4	0.2	0.2	-50
65–74	—	—	1.0	0.6	0.7	0.4	0.8	0.3	0.4	-50
75–84	—	—	2.3	2.9	1.7	1.7	1.5	1.2	0.9	-65
85+	—	—	7.4	10.6	5.2	6.3	3.6	3.6	2.6	-72

[a] Rate per 1,000 population.
[b] Data not shown each year.
[c] Due to several changes in ICD code, trends in this category not statistically reliable. Percent change is calculated for 1950–80.
[d] Percent change calculated for 1970–80.
[e] Percent change calculated for 1950–80.

SOURCES: OTA; based on data from U.S. DHHS, NCHS, 1982 (63,64,65) and 1983 (67) and the Vital Statistics annual reports on mortality in the United States.

Table A-24.—Most Common Problems Coexisting in Elderly Individuals

1. Congestive heart failure
2. Depression
3. Dementia syndrome
4. Chronic renal failure
5. Angina pectoris
6. Degenerative joint disease
7. Gait disturbance
8. Urinary dysfunction
9. Constipation
10. Vascular insufficiency in the legs
11. Diabetes mellitus
12. Chronic pain
13. Sleep disturbance
14. Multiple drug regimens
15. Anemia

SOURCE: Besdine, et al., 1982 (6).

Table A-25.—Disorders Likely to Present Non-Specifically in Old Age

1. Depression
2. Drug intoxication
3. Myxedema
4. Alcoholism
5. Myocardial infarction
6. Pulmonary embolism
7. Pneumonia
8. Cancer
9. Surgical abdomen
10. Thyrotoxicosis, masked or apathetic

SOURCE: Besdine, Levkoff, Wetle, 1983 (7).

Table A-26 summarizes the general conclusions drawn concerning which chronic conditions are rising or falling among the elderly, which exhibit gender or race differences in prevalence, and whether these differences are pronounced.

Degenerative Mental Illness.—Older people represent about one-fifth of all first admissions to psychiatric hospitals and occupy almost one-fourth of all psychiatric beds in the Nation (11). Physiological bases for increasing numbers of mental disorders are emerging, bringing with them hope for treatment and prevention. About 50 to 60 percent of the institutionalized elderly are thought to suffer from organic mental disorders (11). The distinction between organic (physiological) and inorganic (emotional) mental illness remains blurred, however. The interaction of mental and physical disorders also warrants further study; emotional problems and stress can precipitate physical illness and, conversely, chronic illness can cause psychological problems such as depression (11,20).

Two major types of mental illness in the elderly are depression and senile dementia. There are many other illnesses that are significant: almost one out of every three elderly people suffers from a sleep disorder, for example (36). Although estimates for depression range from 10 to 30 percent of those over 65, these figures are suspected to be low because of difficulty in diagnosis (29). Isolation, chronic disease, and terminal illness can all contribute to depression.

Awareness of the prevalence and impact of dementia among our elderly population has only recently taken root (25,38). Some even speculate that it is a major cause of death (26). Dementia, or the progressive deterioration of cognitive function (usually accompanied by changes in emotions and personality), is a clinical syndrome whose underlying causes are varied and ill-defined. The prevalence of severe dementia among the elderly may be approximated at 1 to 6 percent, with that of milder cases ranging from 3 to 15 percent (32). If an average prevalence of 4.1 percent for severe dementia (32) is applied to the 1980 elderly population, it amounts to over 1 million persons. These figures represent a significant public health problem, even when excluding the milder cases that are harder to diagnose.

The prevalence of dementia increases markedly with age, showing a four- to seven-fold increase between persons aged 70-79 and those over 80; cumulative morbidity risk of severe dementia has been estimated to be 20 percent by age 80 (32). Alzheimer disease is the most prevalent form of dementia, accounting for an estimated 50 to 75 percent of dementia cases (see ch. 3). The other types are due to arteriosclerotic brain disease and other specific organic brain disorders. The age-specific prevalence for Alzheimer disease, which is estimated to be 17 percent at age 80, rises almost twofold to 30 percent by age 85 (45).

The prevalence of major mental disorders, particularly depression and senile dementia whose prevalences are known to rise with age, is likely to increase as the very old segment of the U.S. population grows (31). Much research is needed into the causes and risk factors for these debilitating diseases.

Chronic Skin and Musculoskeletal Conditions.—The most prevalent and debilitating among chronic skin and musculoskeletal conditions is arthritis. Arthritis is a type of rheumatism in which the inflammation and degeneration are confined to the joints. This category includes osteoarthritis in which the articular (joint) cartilage degenerates. According to 1981 figures, almost 50 percent of all persons over 65 are afflicted with arthritis. The rate for women is more than 50 percent higher than that for men, and the rate for blacks is higher than that for whites (table A-27). During the 1969-76 period, the prevalence of arthritis increased by 13 percent among the elderly.

Table A-26.—Differential Prevalence of Chronic Conditions Among Persons Aged 65 and Over, by Race and Sex: United States, Recent Trends

Chronic conditions	Race difference	Sex difference
Rising prevalence:		
Heart conditions:	x	
Coronary	**x**[a]	x
Disorders in heart rhythm		x
Unspecified heart trouble	**x**	**x**
Hypertensive disease	**x**	**x**
Poor circulation		x
Chronic bronchitis		x
Emphysema		**x**
Ulcers of stomach and duodenum	x	x
Hernia abdominal cavity	**x**	x
Upper gastrointestinal tract disorders	x	
Arthritis	**x**	**x**
Bone disease		x
Synovitis, bursitis, tenosynovitis		x
Visual impairment	**x**	**x**
Hearing impairment	**x**	**x**
Thyroid problems		**x**
Diabetes	**x**	**x**
All anemias		**x**
Nephritis		
Calculus of kidney		**x**
Sciatica		x
Falling prevalence:		
Hypertensive heart disease	**x**	**x**
Stroke	x	x
Arteriosclerosis		x
Varicose veins	**x**	**x**
Sinusitis		
Frequent constipation	x	**x**
Gallbladder conditions		**x**
Enteritis and ulcerative colitis	**x**	**x**
Gastritis and duodenitis		
Rheumatism (non-articular)	x	x
Corns and callosities		
Severe visual impairment	**x**	x
Paralysis (complete or partial)	**x**	x
Iron deficiency anemia		
Disorders of urinary system	**x**	**x**
Neuralgia and neuritis		**x**
Prostate disease	**x**	

[a] A bold, underscored "x" indicates strong differences; other differences are less notable.

SOURCE: Summarized from data in tables 27-32.

Nonarticular rheumatism (inflammation or degeneration of connective tissue in the body, including muscles and tendons) was less common and, in contrast to arthritis, was more prevalent in elderly men than in women. Rheumatism decreased for all subcategories from 1969 to 1976, although the drop was much less for blacks than for whites (table A-27). Bursitis and other inflammatory diseases of the membranes and other tissues relating to the joints were also fairly prevalent (more so in women) and increased over the period.

Diseases of the bone, including osteomyelitis (inflammation), are generally more prevalent in elderly women than men. The percent increase in prevalence from 1969 to 1976 was more than three times higher in women than in men. Although osteoporosis (loss of bone density leading to brittleness and increased risk of fracture) is supposed to be included in these figures, it is likely that the disease is not well represented. Because osteoporosis is difficult to diagnose, there are no definitive prevalence figures on this costly, debilitating disease (see ch. 3). One case study, however, reported high prevalence of X-ray diagnosed osteoporosis increasing with age among elderly women: 74 percent of those aged 65 to 69, 84 percent of those aged 70 to 74, and 89 percent of those over 75 (23). Much research is needed to develop tools for early diagnosis and to establish the true dimensions of the problem.

Table A-27a.—Prevalence of Chronic Skin and Musculoskeletal Conditions, by Age, Sex, and Race: United States, 1969-76[a] (number per 1,000)

Condition	Total		Male		Female		White		Nonwhite	
	All ages	65+	All ages	65+	All ages	65+	All ages	65+	All ages	65+
1969:										
Arthritis[b]	92.9	380.3	64.6	287.0	119.2	450.1	95.1	376.3	77.2	424. 8
Rheumatism[c]	6.1	23.2	5.7	28.0	6.5	19.6	6.3	22.1	5.0	36.0
Bone diseases	4.5	9.7	4.1	8.0	4.9	11.0	5.0	10.3	[d]	[d]
Synovitis bursitis tenosynovitis	16.5	27.7	15.2	25.0	17.7	29.6	17.8	28.3	6.9	[d]
Corns and callosities	41.5	109.9	24.7	65.5	57.1	143.1	38.8	105.6	61.0	158.5
Skin neoplasms[e]	—	—	—	—	—	—	—	—	—	—
1976:										
Arthritis[b]	116.7	436.6	83.4	337.9	147.7	505.5	2.3	431.9	2.1[d]	482.8
Rheumatism[c]	4.0	16.0	3.5	18.2	4.4	14.5	3.9	14.3	4.3	32.5
Bone diseases	8.0	17.8	7.0	10.7	8.9	22.7	8.8	19.1	2.8	4.9[d]
Synovitis bursitis tenosynovitis	19.0	30.3	16.5	28.3	21.4	31.6	20.7	31.7	8.2	17.2
Corns and callosities	26.5	69.5	17.6	45.7	34.8	86.0	25.1	66.1	36.0	102 .5
Skin neoplasms	5.2	16.8	5.4	19.6	5.0	14.8	5.9	18.3	1.0[d]	3.0[d]
Percent change in rate, 1969–76, age 65+:										
Arthritis[b]	—	+25.6	—	+17.7	—	+12.3	—	+14.8	—	+13.6
Rheumatism[c]	—	−31.0	—	−35.0	—	−26.0	—	−35.3	—	−9.7
Bone diseases	—	+187.2	—	+33.8	—	+106.4	—	+85.4	—	[d]
Synovitis bursitis tenosynovitis	—	+9.4	—	+13.2	—	+6.8	—	+12.0	—	[d]
Corns and callosities	—	−62.3	—	−30.2	—	−39.9	—	−37.4	—	−41.0
Skin neoplasms[e]	—	—	—	—	—	—	—	—	—	—

[a] Based on household interviews of the civilian, noninstitutionalized population.
[b] Not elsewhere classified.
[c] Nonarticular unspecified.
[d] Not statistically reliable.
[e] No data available.

SOURCE: U.S. DHHS, NCHS, 1974 (55) and 1978 (59).

Table A-27b.—Prevalence of Chronic Skin and Musculoskeletal Conditions, by Age and Sex: United States, 1981[a] (number per 1,000)

Condition	Total		Male	Female
	All ages	65+	All ages	All ages
Arthritis[b]	12.1	464.7	87.5	152.3
Rheumatism[c]	2.8	8.9	2.5	3.2
Bone diseases	5.0	11.8	4.8	5.2
Synovitis, bursitis tenosynovitis	21.3	35.7	15.9	26.3
Corns and callosities	19.1	5.9	12.6	25.1
Skin neoplasms	6.0	23.2	6.1	6.0

[a] Based on household interviews of the civilian, noninstitutionalized population.
[b] Not elsewhere classified.
[c] Nonarticular unspecified.

SOURCE: National Center for Health Statistics, unpublished data.

Although comparative data were not available for skin neoplasms, it is worth noting that prevalence among the elderly is more than five times that in the general population and that the prevalence among whites is many times that among blacks (table A-27) due in large part to the relative lack of skin pigment in whites (4). Corns and callosities (thickenings) of the skin may seem relatively trivial but warrant attention due to their prevalence and potential to limit mobility, especially among the very old. These conditions are more than twice as common in women than men.

Selected Impairments.—There are several gender and race differences in the prevalence of visual, hearing, paralytic, and nonparalytic orthopedic impairments—all of which are important causes of disability. Elderly women have higher rates than men for visual impairments and orthopedic impairments of the back and lower extremities. Hearing impairments and partial or complete paralysis, by contrast, are more common in elderly men (table A-28). Blacks over 65 exhibit 20 percent higher prevalence of visual impairments, approaching double the rate among whites for severe visual impairment[5] and for paralysis (table A-28). Whites, however, have 26 to 34 percent higher rates for hearing impairments than blacks. Hearing impairments and most orthopedic impairments become more common with advancing age.

From 1971 to 1977 visual impairments in general tended to rise in prevalence among all elderly groups while severe visual impairments fell (table A-28). Since the most common cause of visual impairment is cataracts, this rise may be due to the increased prevalence of cataracts which, in turn, may be linked to a rise in diabetes (see section on "Other Selected Chronic Conditions"), a major risk factor for cataracts. Hearing impairments rose in prevalence in the 65 to 74 age group but fell in the over-75 group. Paralytic impairments also rose, especially among whites and women. Orthopedic impairments appeared to fall in most groups (table A-28).

Chronic Circulatory Conditions.—The most common chronic circulatory conditions among the elderly are heart conditions (mostly coronary heart disease—CHD) and hypertensive disease. Striking gender and race differences can be found in their prevalences: prevalence of general hypertensive disease is almost 30 percent higher for blacks, whose prevalence of hypertensive heart disease more than twice that of whites (table A-29). Stroke prevalence is also 28 percent higher among blacks. Elderly whites, conversely, have more than twice the prevalence of coronary heart disease and varicose veins. As for gender differences, the prevalences of both general and cardiac hypertensive disease are more than 70 percent higher in elderly women than men (table A-29a). But the prevalence of coronary heart disease is 26 percent higher in elderly men.

The comparatively higher prevalence of hypertensive disease in elderly women and blacks is surprising. Their death rates from heart disease are lower for both as compared to men and whites, respectively, and lower for stroke and hypertensive disease for women (see previous section on "Mortality"). This could mean that hypertension is better controlled, not as severe, or generally not as strong a risk factor for cardiovascular mortality in women and blacks. Also, the high mortality associated with chronic coronary heart disease may considerably raise the death rates of whites and men.

Unfortunately, trends among these subgroups cannot be analyzed because the 1978 data are not subdivided by sex or race. Certain general observations can be made about the 1972-78 period, however (table A-29a): the prevalence of cerebrovascular disease, arteriosclerosis, and varicose veins all fell among the elderly; the prevalence of all heart conditions except hypertensive heart disease rose, particularly among the elderly; coronary heart disease rose the least (1 percent). The available data indicate that the prevalence of general hypertensive disease also rose by more than 26 percent among the elderly.[6]

These simultaneous increases in prevalence and decreases in mortality for heart conditions and hypertension among the elderly in the 1970s indicate that: 1) incidence is increasing; 2) better ongoing treatment of the chronic condition has reduced its associated mortality risk; and/or 3) improved acute care is allowing increasing numbers of people to survive crises and become chronic disease sufferers (see "Conclusion").

Chronic Respiratory Conditions.—All three of the chronic respiratory conditions discussed here—chronic bronchitis, emphysema, and sinusitis—are markedly more prevalent among the elderly. Emphysema, for example, is more than four times more common among those over 65 than in the general population. The prevalence of all but sinusitis is higher in elderly men, especially emphysema, for which the rate is more than five times that of elderly women (table A-30). This gender difference is partly due to the greater number of current and former smokers among men (table A-20a).

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[5] Severe visual impairment is defined by NCHS as no useful sight or blindness in both eyes, or inability to read ordinary newspaper print with either eye even while using corrective lenses.

[6] Comparisons of data on both general and cardiac hypertensive disease are limited in accuracy because the diseases are frequently redefined for data collection purposes; while the trends may be indicative, the specific figures are unreliable.

Table A-28a.—Prevalence of Selected Impairments, by Age, Sex, and Race: United States, 1971-77[a] (number per 1,000)

Condition	Total			Male			Female			White			Nonwhite		
	All ages	65–74	75+	All ages	65–74	75+	All ages	65–74	75+	All ages	65–74	75+	All ages	65–74	75+
1971:															
Visual impairment	47.4	*204.6*[b]		50.8	*183.0*		44.2	*220.4*		47.9	*200.9*		44.3	*245.7*	
Severe	6.5	*47.0*		5.2	*38.3*		7.7	*53.3*		6.0	*44.3*		9.4	*78.1*	
Hearing impairment	71.6	231.1	398.6	80.6	277.8	449.2	63.3	194.4	365.5	75.5	235.3	405.8	11.1	181.4	322.2
Paralysis (complete/partial)	6.9	*23.1*		7.5	*27.5*		6.3	*19.8*		7.1	*21.6*		5.5	*40.0*	
Orthopedic impairments or deformities:															
Back or spine	39.6	68.4	64.9	2.2	55.1	53.6	4.1	79.0	72.3	3.5	67.8	62.4	c	75.9	90.9
Upper extremities	12.1	*29.9*		15.0	*28.7*		9.3	*30.7*		1.9	*30.5*		c	*22.9*	
Lower extremities	36.5	70.8	94.6	39.7	56.2	82.3	15.4	82.3	102.7	19.8	68.9	92.8	16.6	92.8	114.8
1977:															
Visual impairment	53.8	*220.2*		57.7	*204.5*		50.2	*231.1*		54.7	*215.9*		47.8	*261.1*	
Severe	6.6	*44.5*		5.4	*37.2*		7.6	*49.6*		6.2	*41.7*		8.8	*71.3*	
Hearing impairment	76.4	240.6	385.5	87.2	289.1	439.3	66.4	203.3	353.3	81.3	246.7	393.0	45.1	184.1	310.6
Paralysis (complete/partial)	7.2	*26.4*		7.8	*30.3*		6.6	*23.6*		7.1	*24.6*		8.3	*43.7*	
Orthopedic impairments or deformities:															
Back or spine	44.1	65.9	68.1	40.1	57.6	49.3	47.9	72.2	79.3	5.7	66.0	69.3	2.8[d]	65.0	54.3
Upper extremities	11.8	*28.5*		14.5	*29.1*		9.2	*28.0*		12.4	*29.2*		7.8	*21.9*	
Lower extremities	33.7	63.0	89.7	35.6	59.7	74.0	31.9	65.6	99.1	34.0	60.7	89.6	31.7	84.5	90.5
Percentage change in rate, 1971–77:															
Visual impairment	+13.5	*+7.6*		+13.6	*+11.7*		+13.6	*+4.8*		+14.2	*+7.5*		+7.9	*+6.3*	
Severe	+0.2	*−5.3*		−3.8	*−2.9*		−0.1	*−6.9*		+3.3	*−5.9*		−6.4	*−8.7*	
Hearing impairment	+6.7	+4.1	−3.3	+8.2	+4.1	−2.2	+4.9	+4.6	−3.3	+7.7	+4.8	−3.2	+306.3	+1.5	−3.6
Paralysis (complete/partial)	+4.3	*+14.3*		+4.0	*+9.2*		+4.8	*+19.2*		0	*+13.9*		+50.9	*+9.2*	
Orthopedic impairments or deformities:															
Back or spine	+11.4	−3.6	+4.7	c	+4.5	−8.0	c	−8.6	+9.7	+62.9	−2.6	+11.1	c	−14.4	−67.4
Upper extremities	−2.5	*−4.7*		−3.3	*+1.4*		−1.1	*−8.8*		c	*−4.3*		c	*−4.4*	
Lower extremities	−7.7	−11.0	−5.2	−10.3	+6.2	−10.1	+107.1	−20.3	−3.5	+71.7	−11.9	−3.4	+91.0	−8.9	−21.2

[a] Based on household interviews of the civilian, noninstitutionalized population.
[b] Italized numbers are for the total 65 and over age group.
[c] No data available.
[d] Not statistically reliable.

SOURCE: U.S. DHHS, NCHS, 1975 (57) and 1981 (62).

Table A-28b.—Prevalence of Selected Impairments, by Age and Sex: United States, 1981[a] (number per 1,000)

Condition	Total		Male	Female
	All ages	65 +	All ages	All ages
Visual impairment	40.4	136.6	47.8	33.4
Severe[b]	—	—	—	—
Hearing impairment	82.9	283.6	91.1	75.3
Paralysis (complete/partial)	5.9	19.6	7.0	4.8
Orthopedic impairments or deformities	81.8	128.2	86.4	77.6
Back or spine	51.9	73.2	50.4	53.3
Upper extremities	13.2	27.6	15.4	11.0
Lower extremities	23.2	44.5	27.8	19.0

[a] Based on household interviews of the civilian, noninstitutionalized population.
[b] No data available.

SOURCE: National Center for Health Statistics, unpublished data.

The prevalence of sinusitis dropped slightly from 1970 to 1978, while that of the other two conditions rose. Emphysema among the elderly jumped more than 25 percent during this period. The reason for this rising trend is not clear, but it may be linked to the increase in mortality due to obstructive lung disease in some older age groups since 1970 (see "Mortality" section).

Chronic Digestive Conditions.—There is a well-documented age-related rise in the prevalence of many digestive disorders (see ch. 4). The most common chronic digestive condition reported by the elderly is constipation, followed by abdominal hernias. The 1975 NCHS data reveal certain race and gender differences (table A-31). Elderly whites exhibit much higher rates than blacks for abdominal hernias, chronic enteritis, and ulcerative colitis (inflammations of the intestine and colon, respectively), and intestinal diverticula (outpocketings of the intestinal wall that are prone to infection). Elderly women report two to three times the prevalence in men of frequent constipation, gallbladder conditions, intestinal diverticula, and chronic enteritis and colitis. The rate of abdominal hernias, however, is almost 30 percent higher among men.

In the period 1968-75, the prevalence rose for ulcers, abdominal hernias, and particularly for functional and symptomatic disorders of the upper gastrointestinal tract (including the stomach). Prevalence fell for all other conditions, most dramatically for enteritis and colitis.

Other Selected Chronic Conditions.—This category includes chronic thyroid disorders, anemias, diabetes, neurological disorders, and disorders of the urinary tract. According to 1973 data, diabetes is the most common ailment of this category among elderly women, while disease of the prostate is the most common among men.

Both thyroid disorders and anemias are more than three times more prevalent in elderly women than men (table A-32). Women also report higher prevalence of diabetes (50 percent), urinary disorders (60 percent), and specific neurological disorders: sciatica (pain along the course of the sciatic nerve from the lower back into the legs), neuralgia (pain along the course of one or more nerves), and neuritis (inflammation of a nerve). Calculus of the kidney, by contrast, was almost twice as prevalent among men.

From 1973 to 1978 the prevalence of diabetes among the elderly rose by 8 percent. The significance of this rise, when paired with declining death rates for both diabetes and heart disease, is discussed in the conclusion. The dramatic changes found in the prevalences of other conditions—the rises in thyroid problems, anemias, nephritis and calculus of the kidney, and drops in iron-deficiency anemia, neuralgia and neuritis, and diseases of the prostate—may be generally indicative of trends, but are probably exaggerated due to improved diagnostic and reporting techniques. Moreover, the figures on iron-deficiency anemia and nephritis have been statistically unreliable (table A-32).

An important urinary disorder that is not covered in these data is urinary incontinence, the inability to control excretion of urine. Incontinence is most common among the elderly and affects between 10 and 20 percent of community-dwelling elderly to some degree and nearly 50 percent of those in nursing homes (up to 700,000 persons)—about 50 percent of the latter also have episodes of fecal incontinence (16,34). These figures are probably underestimates because they reflect only those afflicted at the time and not those with a history of incontinence (72). The medical and psychosocial impact of incontinence on the Nation's growing elderly population is discussed in a case study accompanying this report.

Table A-29a.—Prevalence of Chronic Circulatory Conditions, by Age, Sex, and Race: United States, 1972-78[a]

(number per 1,000)

Condition	Total		Male		Female		White		Nonwhite	
	All ages	65+	All ages	65+	All ages	65+	All ages[a]	65+	All ages	65+
1972:										
Heart conditions	50.4	198.7	48.0	199.3	52.7	198.3	51.7	200.0	41.5	185.2
Coronary	16.2	84.0	19.0	95.7	13.6	75.7	17.8	89.7	5.1	24.6
Unspecified disorders:										
Heart rhythm[b]	12.0	22.0	10.0	21.0	13.7	22.7	12.4	23.0	8.8	c
Heart trouble[b]	5.8	28.1	6.9	36.0	4.8	22.3	5.7	27.0	6.4	38.9
Hypertensive disease[b]	10.5	52.8	7.4	36.6	13.3	64.4	9.6	47.7	17.2	105.8
Hypertensive disease[d]	60.1	199.4	46.4	141.2	72.9	240.9	58.3	194.6	72.9	248.7
Cerebrovascular disease	7.5	48.2	7.6	54.0	7.4	44.0	7.3	47.0	9.1	60.0
Arteriosclerosis[d]	3.4	25.7	3.5	30.0	3.4	22.7	3.8	27.2	c	c
Varicose veins[d]	36.8	93.9	14.5	52.2	57.6	123.8	39.4	99.6	18.7	34.3
Poor circulation[b]	4.6	24.1	3.4	19.8	5.7	27.2	4.7	24.7	3.6	c
1978:										
Heart conditions	62.9	214.6	60.8	—	64.7	—	—	—	—	—
Coronary	18.4	84.8	20.9	—	16.0	—	—	—	—	—
Unspecified disorders:										
Heart rhythm[b]	14.7	23.8	12.6	—	16.6	—	—	—	—	—
Heart trouble[b]	8.5	45.5	10.5	—	6.6	—	—	—	—	—
Hypertensive disease[b]	13.0	45.3	10.4	—	15.4	—	—	—	—	—
Hypertensive disease[d]	87.8	251.6	72.1	—	102.4	—	—	—	—	—
Cerebrovascular disease	80.0	44.9	9.4	—	6.7	—	—	—	—	—
Arteriosclerosis[d]	3.4	25.1	3.4	—	3.4	—	—	—	—	—
Varicose veins[d]	30.0	75.4	12.4	—	46.4	—	—	—	—	—
Poor circulation[b]	5.3	25.1	4.6	—	6.0	—	—	—	—	—
Percentage change in rate, 1972-78:										
Heart conditions	+24.8	+8.4	+26.7	—	+22.8	—	—	—	—	—
Coronary	+13.6	+1.0	+10.0	—	+17.6	—	—	—	—	—
Unspecified disorders:										
Heart rhythm[b]	+22.5	+8.2	+26.0	—	+21.2	—	—	—	—	—
Heart trouble[b]	+46.5	+61.9	+52.2	—	+37.5	—	—	—	—	—
Hypertensive disease[b]	+23.8	−14.2	+40.5	—	+15.8	—	—	—	—	—
Hypertensive disease[d]	+46.1	+26.2	+55.4	—	+40.5	—	—	—	—	—
Cerebrovascular disease	+6.7	−6.8	+23.7	—	−9.5	—	—	—	—	—
Arteriosclerosis[d]	0.0	−2.3	−2.9	—	0.0	—	—	—	—	—
Varicose veins[d]	−18.5	−19.7	−14.5	—	−19.4	—	—	—	—	—
Poor circulation[b]	+15.3	+4.2	+35.3	—	+5.3	—	—	—	—	—

[a] Based on household interviews of the civilian, noninstitutionalized population.
[b] Not otherwise specified.
[c] Not statistically reliable.
[d] Not elsewhere classified.

SOURCE: U.S. DHHS, NCHS, 1974 (56) and unpublished data.

Table A-29b.—Prevalence of Chronic Circulatory Conditions, by Age and Sex: United States, 1981[a] (number per 1,000)

Condition	Total		Male	Female
	All ages	65+	All ages	All ages
Heart conditions	76.4	277.0	80.7	81.6
Coronary	25.2	117.7	29.1	21.6
Unspecified disorders:				
Heart rhythm[b]	27.5	60.2	20.9	33.7
Heart trouble[b]	11.5	63.5	10.2	12.7
Hypertensive disease[b]	0.7	3.1	0.3	1.0
Hypertensive disease[c]	113.4	378.6	100.4	125.5
Cerebrovascular disease	8.3	45.4	8.7	8.0
Arteriosclerosis[c]	15.1	97.0	15.8	14.5
Varicose veins[c]	27.2	83.2	10.4	43.0
Poor circulation[b]	3.1	18.1	2.5	3.7

[a] Based on household interviews of the civilian, noninstitutionalized population.
[b] Not otherwise specified.
[c] Not elsewhere classified.

SOURCE: National Center for Health Statistics, unpublished data.

Table A-30a.—Prevalence of Chronic Respiratory Conditions, by Age, Sex, and Race: United States, 1970-78[a] (number per 1,000)

Condition	Total		Male		Female		White		Nonwhite	
	All ages	65+	All ages	65+	All ages	65+	All ages	65+	All ages	65+
1970:										
Chronic bronchitis	32.7	41.2	31.2	47.3	34.0	36.6	34.4	42.5	20.0	b
Emphysema	6.6	31.7	10.3	58.8	3.1	11.6	7.4	34.3	b	b
Sinusitis	103.0	136.1	92.6	121.5	112.6	147.1	110.0	141.1	53.2	79.2
1978:										
Chronic bronchitis	33.0	47.4	29.0	—	36.8	—	—	—	—	—
Emphysema	9.7	39.8	14.4	—	5.2	—	—	—	—	—
Sinusitis	105.4	129.9	96.3	—	114.0	—	—	—	—	—
Percentage change in rate 1970–78:										
Chronic bronchitis	+0.9	+15.0	+7.0	—	+8.2	—	—	—	—	—
Emphysema	+47.0	+25.5	+39.8	—	+67.7	—	—	—	—	—
Sinusitis	+2.3	−4.5	+4.0	—	+1.2	—	—	—	—	—

[a] Based on household interviews of the civilian, noninstitutionalized population.
[b] Not statistically reliable.

SOURCE: U.S. DHHS, NCHS, 1973 (53).

Table A-30b.—Prevalence of Chronic Respiratory Conditions, by Age and Sex: United States, 1981 (number per 1,000)[a]

Condition	Total		Male	Female
	All ages	65+	All ages	All ages
Chronic bronchitis	35.3	46.1	31.7	38.7
Emphysema	9.3	42.9	14.3	4.6
Sinusitis	137.9	183.6	121.0	153.7

[a] Based on household interviews of the civilian, noninstitutionalized population.

SOURCE: National Center for Health Statistics, unpublished data.

Table A-31a.—Prevalence of Chronic Digestive Conditions, by Age, Sex, and Race: United States, 1968-75[a]

Condition	Total		Male		Female		White		Nonwhite	
	All ages	65+	All ages	65+	All ages	65+	All ages	65+	All ages	65+
1968:										
Ulcer of stomach/duodenum	17.2	29.0	22.0	38.4	12.6	22.0	17.8	29.8	12.5	b
Frequent constipation	23.8	96.3	13.7	62.5	53.1	121.9	23.8	96.5	23.7	94.3
Hernias of abdominal cavity	16.3	58.8	20.9	80.9	12.0	42.2	17.1	61.0	10.5	33.9
Functional/symptomatic upper GI tract disorders	13.1	37.7	13.5	32.4	12.7	41.7	13.4	37.8	11.1	36.6
Gall bladder conditions	10.3	32.8	5.0	17.3	15.1	44.6	10.7	32.7	7.5	33.9
Gastritis/duodenitis	8.6	24.0	7.1	17.7	10.0	28.7	8.8	23.6	7.5	b
Diverticula of intestine[b]	—	—	—	—	—	—	—	—	—	—
Chronic enteritis/ulcerative colitis	9.3	34.0	5.7	13.4	12.7	49.6	10.4	36.6	b	b
1975:										
Ulcer of stomach/duodenum	18.9	30.8	20.7	36.9	17.2	26.5	19.5	31.3	15.2	25.7
Frequent constipation	18.2	67.1	8.9	43.6	26.9	83.6	17.5	65.5	23.2	83.6
Hernias of abdominal cavity	17.8	62.2	19.4	71.2	16.4	55.9	19.2	66.1	8.4	23.1
Functional/symptomatic upper GI tract disorders	16.6	38.5	17.3	37.4	15.9	39.3	16.5	38.0	17.1	44.6
Gall bladder conditions	7.8	22.0	3.0	10.6	12.2	30.1	8.0	22.1	6.1	21.0
Gastritis/duodenitis	7.0	17.4	5.8	15.4	8.1	18.8	7.0	17.3	6.9	18.5
Diverticula of intestine	6.3	31.0	3.6	17.4	8.8	40.5	7.2	38.8	0.7[c]	3.1[c]
Chronic enteritis/ulcerative colitis	5.7	13.5	3.6	8.5	7.6	17.0	6.3	14.6	1.4	2.6[c]
Percentage change in rate, 1968–75:										
Ulcer of stomach/duodenum	+9.0	+6.2	-5.9	-3.9	+36.5	+20.4	+9.6	+5.0	+21.6	b
Frequent constipation	-23.5	-30.3	-35.0	-30.2	-18.7	-23.2	-26.5	+32.1	-2.1	-11.3
Hernias of abdominal cavity	+9.2	+5.8	-7.2	-12.0	+36.7	+32.5	+12.3	+8.4	-20.0	-31.8
Functional/symptomatic upper GI tract disorders	+26.7	+2.1	+28.1	+15.4	+25.2	-5.8	+23.1	+0.5	+54.0	+21.9
Gall bladder conditions	-24.3	-32.9	-40.0	-42.2	-19.2	-32.5	-25.2	-32.4	-18.7	-38.0
Gastritis/duodenitis	-18.6	-27.5	-18.3	-13.0	-19.0	-34.5	-20.4	-26.7	-8.0	b
Diverticula of intestine[b]	—	—	—	—	—	—	—	—	—	—
Chronic enteritis/ulcerative colitis	-38.7	-60.3	-36.8	-36.6	-40.2	-65.7	-39.4	-60.1	b	b

[a] Based on household interviews of the civilian, noninstitutionalized population.
[b] No data available.
[c] Not statistically reliable.

SOURCE: U.S. DHHS, NCHS, 1973 (52) and 1979 (60).

Table A-31b.—Prevalence of Chronic Digestive Conditions, by Age and Sex: United States, 1981[a] (number per 1,000)

Condition	Total		Male	Female
	All ages	65+	All ages	All ages
Ulcer of stomach/duodenum	17.5	28.8	17.7	17.2
Frequent constipation	16.0	52.2	8.5	23.0
Hernias of abdominal cavity	16.4	49.1	17.6	15.4
Functional/symptomatic upper GI tract disorders	17.4	39.9	17.5	17.2
Gall bladder conditions	6.8	18.5	2.5	10.7
Gastritis/duodenitis	7.2	10.7	5.2	9.1
Diverticula of intestine	6.8	38.4	3.6	9.7
Chronic enteritis/colitis	9.5	16.5	6.6	12.3

[a] Based on household interviews of the civilian, noninstitutionalized population.

SOURCE: National Center for Health Statistics, unpublished data.

Table A-32.—Prevalence of Other Selected Chronic Conditions, by Age, Sex, and Race: United States, 1973-78[a] (number per 1,000)

Condition	Total		Male		Female		White		Nonwhite	
	All ages	65+	All ages	65+	All ages	65+	All ages	65+	All ages	65+
1973:										
Thyroid	13.9	19.7	3.7	7.3	23.4	28.4	14.9	20.2	7.1	[b]
Diabetes	20.4	78.5	16.3	60.3	24.1	91.3	19.9	75.9	23.9	104.5
All anemias	14.5	20.9	4.6	8.0	23.7	30.2	13.7	22.3	20.4	[b]
Iron deficiency	3.2	2.6	1.0	[b]	5.2	3.9	3.1	2.9	3.5	[b]
Sciatica	4.3	11.9	3.4	9.8	5.1	13.4	4.9	12.7	[b]	[b]
Neuralgia/neuritis	1.9	9.0	1.1	6.7	2.8	10.7	2.1	9.5	[b]	[b]
Urinary system disease	28.0	60.7	14.1	44.8	41.0	72.0	28.3	59.1	26.4	77.7
Nephritis	0.7	1.0	0.5	[b]	0.9	1.5	0.7	1.1	[b]	[b]
Calculus kidney	3.3	7.0	3.9	9.9	2.7	5.0	3.4	6.4	2.5	[b]
Prostate disease	—	—	13.1	66.8	—	—	3.6	68.3	[b]	51.6
1978:										
Thyroid	13.6	25.6	2.2	—	24.1	—	—	—	—	—
Diabetes	24.3	84.8	20.1	—	28.2	—	—	—	—	—
All anemias	13.0	27.0	4.8	—	20.7	—	—	—	—	—
Iron deficiency	2.0	1.5[b]	0.1[b]	—	3.8	—	—	—	—	—
Sciatica	4.5	13.0	2.5	—	6.4	—	—	—	—	—
Neuralgia/neuritis	2.5	6.1	1.5	—	3.5	—	—	—	—	—
Urinary system disease	25.9	56.6	14.6	—	36.4	—	—	—	—	—
Nephritis	0.9	1.7[b]	1.1	—	0.8	—	—	—	—	—
Calculus kidney	4.0	11.0	4.7	—	3.4	—	—	—	—	—
Prostate disease	—	—	13.2	28.7	—	—	—	—	—	—
Percentage change in rate, 1973–78:										
Thryoid	−2.2	+29.9	−40.5	—	+3.0	—	—	—	—	—
Diabetes	+19.1	+8.0	+23.3	—	+17.0	—	—	—	—	—
All anemias	−10.3	+29.2	+4.2	—	−12.7	—	—	—	—	—
Iron deficiency	−37.5	−42.3[b]	—[b]	—	−26.9	—	—	—	—	—
Sciatica	+23.2	+9.2	−26.5	—	+25.5	—	—	—	—	—
Neuralgia/neuritis	−31.6	−32.2	−36.4	—	−25.0	—	—	—	—	—
Urinary system disease	−7.5	−6.8	+3.5	—	−11.2	—	—	—	—	—
Nephritis	+28.6	+70[b]	+120.0	—	−11.1	—	—	—	—	—
Calculus kidney	+21.2	+57.1	+20.5	—	+25.9	—	—	—	—	—
Prostrate disease	—	—	−0.8	−57.0	—	—	—	—	—	—

[a] Based on household interviews of the civilian, noninstitutionalized population.
[b] Nct statistically reliable.

SOURCE: U.S. DHHS, NCHS, 1977 (58).

Conclusions

Older Americans are very heterogeneous according to age, sex, and race-specific prevalences and death rates for many conditions. Some general conclusions can be drawn from available data on the health and functional status of the elderly, recent trends in their mortality and morbidity, and the cross-analyses of these trends. These, in turn, yield further implications for our health care system:

- Mortality:
  - The overall death rate of elderly women was consistently lower than that of elderly men and decreased almost twice as much from 1940 to 1978.
  - Death rates for both heart disease and stroke declined most rapidly among the elderly in the 1968-78 period and were generally lower for women.
  - Cancer and chronic obstructive pulmonary disease are the only major causes of death for which rates have risen recently among the elderly. The rise in cancer is mostly due to a dramatic rise in lung cancer among men; rates among women have also risen since the mid-1960s, probably due to the increased proportion of women who smoke.
  - Mortality from diabetes mellitus has fallen since 1940 except among those over 85; in this group the rate almost doubled.
- Morbidity:
  - The age-specific prevalence of Alzheimer disease is estimated to be 17 percent at age 80, rising almost twofold to 30 percent by age 85.
  - Almost 50 percent of all persons over 65 are afflicted with arthritis. The rates for elderly women are 50 percent higher than those for elderly men.
  - The prevalence of visual, hearing, and paralytic impairments—all particularly debilitating conditions—rose in some elderly age groups.
  - The prevalence of chronic hypertension, most types of chronic heart disease, and diabetes—all risk factors for cardiovascular mortality—rose in the 1970s.
  - Elderly blacks exhibit a much higher prevalence of hypertensive disease and stroke than whites, although the latter exhibit twice the prevalence of coronary heart disease.
  - Elderly women have a 70 percent higher prevalence of general hypertensive disease than elderly men, but the latter have a 26 percent higher prevalence of coronary heart disease.
  - There is a lack of accurate prevalence data for dementia, cancer, and osteoporosis, and a general lack of prevalence data subdivided by age groups above age 65.
- Cross analyses:
  - The prevalences of general hypertension, diabetes, and most chronic heart conditions—all risk factors for cardiovascular disease—are rising at the same time cardiovascular mortality is falling. This probably indicates better treatment of these chronic conditions, which reduces associated risk, and improved acute care, which allows more people to survive crises, live longer, and develop chronic illnesses.
  - The paradox of higher prevalence of hypertension and declining heart disease mortality in elderly blacks and women (also stroke and hypertension in the latter) suggests that hypertension is better controlled, less severe, or generally not as strong a risk factor in these groups.
  - Both the prevalence and the death rate are rising for chronic lung disease, indicating that the incidence is also rising. The rising incidence of lung disease and of certain cancers—especially cancer of the lung and gastrointestinal tract—are probably linked to rises in controllable risk factors such as smoking and dietary habits, that could be addressed through health promotion education.
  - The prevalence and death rates for stroke (the third leading killer among the elderly) are both falling. This indicates that incidence is falling and that risk factors like high blood cholesterol have been behaviorally reduced and/or reduced through medical treatment.

In sum, *death rates* for most major causes of death continue to fall, both among the elderly and in the general population. The *prevalence* of more than half of the *chronic conditions* examined in this chapter, however, is rising. If these trends continue, they could result in a decrease in the general well-being of older Americans—especially the very old—and a long-term burden on our health care system—especially for conditions with high associated disability such as arthritis, heart conditions, and visual and hearing impairments. More intensive research into the causes and progression of chronic conditions that become more common with age may lead to more effective prevention, better diagnostic techniques, and improved treatment to reduce disability. More emphasis on preventive health strategies and education of the public about controllable risk factors may help to delay onset or to eventually eliminate these conditions and their associated disabilities.

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Appendix B

The Cell Biology of Aging

Introduction

The distinction between the effects of aging as a chronological process and diseases whose prevalence increase with advancing age remains blurred. Conditions once thought to be inevitable companions of old age are now known to in fact be pathological in origin and thus possibly treatable and preventable. One example is senile dementia, no longer the mysterious fate of the very old, but often a clinical manifestation of arteriosclerotic or biochemical brain disease.

Further research may elucidate the mechanisms underlying aging and their possible connection to age-related diseases, leading to the development of medical techniques that delay the onset and progression of symptoms. While it may not lead to actual extension of the human life span, such knowledge could reduce the prevalence and impact of chronic conditions that affect many elderly persons and drain our health care resources, allowing marked improvement in the general well-being and productivity of the growing elderly segment of the population.

The cell is the physiological building block in all higher organisms, including humans. Any investigation of mechanisms underlying the aging process must therefore look at how different cell types are altered over time to produce the structural and biochemical changes normally associated with aging. Numerous biological signs of aging have already been identified in cells both within the human organism and grown on artificial media. This section reviews the theories and evidence concerning mechanisms underlying biological aging.

Theories about cellular mechanisms of aging

Theories about the cellular mechanisms underlying the aging process can be divided into two broad categories: 1) those involving a "biological clock" that orchestrates degenerative processes and determines life span; and 2) those involving accumulated damage, mutations, and waste products in certain cells.

BIOLOGICAL CLOCK THEORIES

The biological clock theory proposes that an organism is inherently programmed to begin aging at a certain rate according to its chronological age. Evidence for this theory includes the observation that different species of higher vertebrates have very specific life spans that seem to be "programmed" into them according to species. Mechanisms underlying this programmed aging could involve an intrinsic genetic component of the tissues (24), and/or an extrinsic "neuroendocrine pacemaker" (16,17).

The genetic version of the biological clock is bolstered by the observation that the survival time of tissues grafted (or transferred) from an older animal into a younger one of the same species seems to depend on the age of the donor and is not influenced by the "younger" environment into which it has been introduced (24). Similarly, when nuclei from younger cells are transplanted into the cytoplasm of older cells, the recipients then live longer and regain the ability to replicate. These observations all suggest that a "clock" controlling aging does exist and may be located in the nucleus, possibly in the genetic material (24).

Genetic diseases that accelerate aging and abbreviate life spans further support intrinsic genetic control of aging. Werner's syndrome, for example, is a rare autosomal recessive disease (i.e., the gene for the disease is not carried on a sex chromosome and two copies of it must be present for the disease to appear) involving retarded growth, premature graying and loss of hair, cataracts, teeth loss, osteoporosis, adult-onset diabetes, generalized atherosclerosis, and a median life span of 47 years. Cultured fibroblasts from people with Werner's syndrome exhibit a markedly abbreviated life span (23,53). Hutchinson-Gilford Progeria syndrome, another rare "age-accelerating" genetic disease, has similar symptoms that appear by age 1 and a median life span of 12 years. More than 80 percent of the deaths are due to heart disease (23). Localization of the exact gene lesions and their role in accelerating the aging process in these diseases could reveal genetic mechanisms involved in normal aging.

The control of aging by a "neuroendocrine pacemaker" extrinsic to the tissues involved is supported by evidence of progressive changes in neural and endocrine regulatory systems throughout adult life (17); such changes would produce a "cascade" of alterations in neural, endocrine, and tissue interactions, leading to the dysfunction of cells in the ovary, liver, and other target tissues (16). This neuroendocrine pacemaker could produce both cellular and physiological changes associated with aging. The mechanism driving these regulatory changes may involve the cumulative impact of specific hormones on the brain over time. After a certain amount of exposure, negative feedback at the hypothalamic level would cause changes in the homeostatic set points, causing altered neuroendocrine output and the observed functional and structural changes associated with aging.

This neuroendocrine pacemaker could also produce age-related disease by affecting genetic activity, leading to disturbances in immune function, proliferation of arterial walls, malignant growths, and other conditions that are associated with aging and limited life span in mammals (17).

It is not known, however, whether observed age-related changes in hormonal regulation and balance are a cause or an effect of the aging process (30). Furthermore, the biological clock may have both an intrinsic genetic and an extrinsic neuroendocrine component. Much research remains to be done before any conclusions may be drawn concerning programmed aging.

ACCUMULATION OF DAMAGE: FREE RADICALS AND OTHER HARMFUL AGENTS

The other major cellular theory of aging involves the accumulation of physical and biochemical damage to both genetic and nongenetic components of body cells over time. Such cumulative damage would most affect cells that do not normally divide, like liver, heart muscle, and nerve cells.

Free radicals are byproducts of cellular metabolism that are capable of generating chemical reactions destructive to parts of the cell. As the cell continues to metabolize over time, such damage may increase. Some evidence suggests that free-radical damage may be responsible for decomposition of certain cell parts and the subsequent accumulation of lipofuscin ("age pigments") in various body tissues. Accumulation of lipofuscin, and of partially digested materials that have also been found in aging cells, may impair cell function and contribute to cell aging (3,4). Thus, the metabolic process itself may damage the cell over time and contribute to aging.

Accumulated damage with age could also be manifested by genetic lesions produced by mutations or mechanical disruptions of the chromosomes (37,41,48). Such damage could be exacerbated by a possible age-related deficiency in genetic repair mechanisms (13,36) and could result in the manufacture of faulty proteins (e.g., enzymes, hormones, neurotransmitters) that cannot work properly (18).

Several of the genetic "age-accelerating" diseases, including xeroderma pigmentosum and Cockayne's syndrome, seem to involve defects in the cells' genetic repair mechanisms (23,53). People afflicted with either disease show increased frequencies of chromosomal aberrations and their body cells are unusually sensitive to the mutation-inducing properties of ultraviolet light. The symptoms of both of these diseases include premature death and early onset of dementia and various age-related degenerative neurological disorders.

Aberrant proteins could also accumulate both inside and outside cells due to age-related defects in the genetic material or in other protein-manufacturing machinery in the cell. The chemicals and structures responsible for "decoding" and implementing genetic information could alter with age, resulting in structurally faulty proteins that would be unable to function normally (31).

Accumulated insults to the cell over time—whether metabolic, environmental, or viral—could thus lead to cellular degeneration, loss of function, cessation of division, and cell death with a diminution of function in various body organs. Such acquired lesions could also lead to the formation of malignant cells and cancer. The damage could be exacerbated by the aging immune system's decreasing ability to detect and destroy aberrant cells and materials in the body.

Much research remains to be done, however, on the accumulation of either genetic or nongenetic cellular lesions as a function of age, and on the role of such lesions in the aging process. Such knowledge could lead to preventive or therapeutic techniques that prevent or correct this age-related damage along with any associated debilitating symptoms.

Biological signs of aging

Certain systemic changes are generally acknowledged to characterize "normal" aging. Those body functions that decline with age include: renal blood flow (44), cardiac output (especially during exercise; 20), glucose tolerance (1), vital lung capacity (27), and cellular immunity (2).

The great variation in the incidence and degree of such age-related changes and diseases between people of the *same* age suggests that individual behavior and physiology influence the aging process. Better understanding of causal factors underlying age-related conditions could thus lead to better preventive and therapeutic treatments.

This section briefly reviews what is known and not known about the cellular basis of these and other biological changes occurring with age, and what connections there might be between these changes and age-related disease. The etiology and clinical impact of many of these "signs" are not known.

CELL LOSS

Cell death in certain tissues could contribute to the degeneration and death of the organism. In fact, while it is not the sole cause, the loss of cells in certain regions of the body is thought to contribute significantly to the aging process. Such loss is particularly important in tissues whose cells are unable to renew themselves, such as nerve and heart muscle cells.

In certain regions of the brain, nerve cells appear to be lost with advancing age (5), reaching 20 to 40 percent loss in some areas (10). Age-related loss of neurons in the brain's cerebral cortex (5,7), cerebellum (21), and limbic system (45) could be involved in impairment of cognitive, motor, and learning/emotional behavior, respectively, in the elderly. Alzheimer disease, a type of senile dementia found mostly in older persons, is associated with substantial loss of cells from specific brain regions, perhaps leading to clinical disruption of learning and memory.

The scattered loss of muscle fibers from the heart and their replacement with noncellular fibrous strands is observed in aging animals (29), along with a generally decreased proportion of muscle to connective tissue and fat, both in the heart and skeletal muscles. Alteration in the muscles controlling lung ventilation and their responsiveness to neural stimulation, although not necessarily involving cell death, may contribute to acute and chronic difficulty in breathing.

In the kidney, a deterioration of excretory function with age is accompanied by a steady decrease in the number of the organ's microscopic filtering units, or nephrons. Losses of 40 to 50 percent of the maximum number of nephrons can occur by age 70 (38). This loss and other age-related cellular changes could be related to functional decline of the kidney in the elderly, including a decrease in glucose resorption, water clearance, and total acid excretion. This reduces an elderly person's ability to maintain physiological balance of blood components, and can lead to excess circulating amounts of drugs if dosages are not adjusted to account for diminished kidney function.

Other organs undergoing appreciable atrophy with age include the thymus, ovaries, uterus, and testes (29). Hormonal changes in the elderly are suspected to contribute to these phenomena (see sections on cancer and hormonal changes for details and implications).

CESSATION OF CELL DIVISION

The mechanisms that control cell proliferation and limit the replicative life span of normal cells are unknown, but could be significant in the aging process of the cell and the organism as a whole. Evidence based on observations first made by Hayflick (25) suggests that some cells in the body can reproduce for a limited number of generations; when grown in tissue culture (i.e., in laboratory dishes with a special mixture of nutrients), they cannot divide indefinitely. In fact, turnover of cells in areas where they are sloughed off and renewed constantly (as in the skin or intestine) may decrease with age and lead to a net loss of cells. For example, there is a marked flattening and loss of cells in both the inner and outer skin layers of the elderly, along with impaired wound healing.

The relevance of a limited number of cell generations to the life span of the organism as a whole, however, has not been established. Study of cell lines that continue to proliferate indefinitely, like cancer cells, might yield clues to the mechanisms underlying the limited replicative life spans of normal cells.

CHANGES IN CELL MORPHOLOGY

A decrease in the density of synapses (areas across which nerve cells signal each other) has been reported in certain regions of aging brains in humans (26,45) and animals (4,19,22). Loss of dendrites (signal receptors) from certain nerve cells has been observed in the cortex of elderly persons with senile dementia (8,45) and in several brain regions of aging laboratory animals (14,15,32,33,34,50). Degeneration of nerve cell axons (signal receivers) is also seen in the brains of old laboratory animals (19,40). All of these changes could reduce connectivity between nerve cells in the brain and possibly cause impaired brain function in the elderly. For more detail, see the OTA background paper, *Impacts of Neuroscience,* published separately as part of this assessment.

In addition, the nerve cell's outer membrane often exhibits a loss of transmitter receptors and increased rigidity with age. Membrane rigidity reduces the active transport of ion exchange, thereby reducing transmitter efficiency. These changes may also inhibit cell signaling by altering sensitivity to hormones, growth factors, and neurotransmitters.

The increased rigidity observed in the surface membranes of cells other than neurons, including lymphocytes (immune cells) and liver cells, may be due to a generalized increase in the cholesterol: phospholipid ratio of the membrane, possibly leading to a decrease in cell motility and function. The clinical effects of this change are unknown.

The elastic properties of lung tissue also decline with age and could contribute to the impeded ventilation and reduced rate of metabolic gas exchange seen in the elderly. Degeneration of the lung parenchymal tissue and a reduction in its capillary bed has been associated with emphysema. Further research is needed into the effect of environmental pollutants, including tobacco smoke, on lung tissue. Chronic obstructive lung disease, including emphysema, is the fifth leading cause of death among the elderly today, has a rising mortality rate, and is increasing in prevalence as a debilitating chronic condition (see app. A).

CHANGES IN MATERIALS INSIDE THE CELL

The possible accumulation of damage to the cell's internal machinery underlies one of the major theories of aging discussed earlier. Such a cumulative effect is especially important in cells that do not normally divide frequently (e.g., liver parenchymal cells) and those incapable of dividing at all (e.g., nerve, muscle, and egg cells). Such damage could be due to accidents, disease, and/or the effects of normal metabolism over time that may adversely affect such vital cell functions as protein synthesis.

As cells metabolize they produce deleterious byproducts. Free radicals, for example, are extremely reactive substances given off by the mitochondria (the cell's "energy generators") during respiration that can trigger chemical reactions destructive to cell structures. A major consequence of such oxidative damage is lipid peroxidation, (39) which has been implicated in the formation of lipofuscin, a yellow-brown "age pigment" found in some nerve, muscle, and liver cells of old animals and humans (29,30). It is not known whether lipofuscin interferes with cellular function, but drugs that inhibit the formation of lipofuscin in mice resulted in a mean extension of life span.

In old cells, damage to the intracellular sac that contains digestive enzymes may also occur, resulting in a leakage of destructive enzymes out into the cytoplasm that damages the cell (30). Other malfunctions could result from the accumulation of partially degraded cell parts that would normally be totally degraded into reusable components after they have "worn out."

Senescent nerve cells often collect abnormal filaments that progressively fill the cell body and dendrites, replacing the normal cellular "skeleton" thought to be vital to many cell functions. This condition is found in normal aging and, to a greater extent, in such diseases as Down's syndrome and senile dementia (12,28). Similarly, massive quantities of filamentous protein have been observed to accumulate in aging cells in tissue culture. The effect of such changes in cellular architecture is unknown, but they may interfere with some functions, including the internal movement of cell components.

Another vital class of cellular proteins is the receptor proteins that are specifically adapted to receive chemical signals from outside the cell in order to modify cell function. For example, cells in the adrenal gland are instructed by chemicals from another gland via such receptors to release stress hormones into the blood. Certain kinds of receptors in the cell cytoplasm (fluid interior) seem to undergo an age-related decrease in number that has been correlated with decreased responsiveness of the cell to certain hormones, including sex hormones, disrupting their usual regulatory functioning (43). It is possible that the age-related loss of hormonal function—implicated in disorders ranging from diabetes to immune deficiency (see section on hormonal changes)—could stem from a loss of available receptors, whether by a decrease in their production, an increase in their breakdown, or a "masking" of the receptors by a competing protein.

CHANGES IN CELLULAR PROTEIN AND EXTRACELLULAR MATERIALS

There is evidence of changes in cell protein with age, both through changes in the amount and kind synthesized, and in their structural integrity over time (30). In general, there seems to be an overall decrease in rate of protein synthesis in most of the tissues of older animals (46). Protein synthesis is vital to the maintenance of cells, many parts of which "wear out" with time and are replaced continuously. Malfunctioning of the synthetic process could lead to the general disrepair and degeneration of a cell.

In several tissues, synthesis of structural proteins ceases in the adult (e.g., cartilage), child (tooth dentine), or even before birth (eye lens proteins). During aging, these proteins may be progressively altered, leading to diminished function. Structural changes in the lens proteins of the eye, for example, could "stiffen" the lens, hindering the ability to focus and resulting in the deterioration of near vision that is almost universal in the elderly. Cataracts, a clouding of the lens, may also result from structural changes in lens proteins (35).

One of the most well-known biological aging processes involves structural changes in certain extracellular proteins that are normally responsible for the structural integrity of many tissues. For example, cross-linking of collagens—proteins that lend strength and stability to joints, tendons, and the skin—reaches a constant level at maturation (49). The cross-links, however, seem to be damaged with advancing age (possibly by free radicals) to produce a stiffening of connective tissue and thickening of basement membranes, both of which may impede cell function. This may contribute to the loss of elasticity in the skin of elderly persons.

Cross-linking of collagen in joint cartilage may contribute to osteoarthritis (age-related degradation of the extracellular matrix that provides cartilage elasticity has also been implicated in degenerative arthritis). Cross-linking may also contribute to the thickening of the basement membrane of the kidney's glomeruli (minute structures responsible for initial filtration of the blood). This could impede filtration and exacerbate the loss of excretory competence with age.

The protein mesh maintained on the surface of almost all cells also seems to be biochemically altered with age. The matrix is normally involved in cell attachment, shape, migration, and perhaps in cell division—functions that could be affected by alteration of its constituent proteins.

Other extracellular components varying with age contribute to the development of diseases more prevalent in the aged. Deposition of lipid-containing plaques along the inner walls of arteries, or atherosclerosis, occurs mostly in the elderly and underlies many forms of cardiovascular disease. Deposition of amyloid (a waxy substance consisting of proteins and sugars) in blood vessels, characteristic of a variety of diseases, is found consistently in the elderly and mainly in the kidneys, heart, pancreas, adrenal gland, and central nervous system (29). The clinical impact of such deposits is undetermined but could involve impaired function of these organs.

Disorders involving decrease in bone mass (osteoporosis) or in the calcium content of the bone (osteomalacia) account for a large portion of chronic disabilities in the elderly, including increased susceptibility to fracture due to a weakening and brittleness of the bones (see ch. 3). Defects in vitamin D metabolism, hormone imbalances, and inactivity have all been implicated in disturbing the complex balance between the continual absorption and deposition of bone by specialized cells.

ABNORMAL CELL PROLIFERATION AND CANCER

Hyperplasia, or the abnormal proliferation of cells in certain body tissues is often observed in the elderly. Cancer, or malignant neoplasia, is second only to cardiovascular disease as a cause of death in the United States (see app. A). The chances that a person will develop cancerous growths within a 5-year period rise from 1 in 700 at age 25 to 1 in 14 at age 65. The overall incidence of cancer peaks between ages 40 and 80, although certain forms of cancer (e.g., leukemia, lymphoma, and prostatic cancer) are more prevalent in older age groups.

Hyperplasia is found in a variety of localized regions in the elderly, including hyperplastic and malignant growths in the endocrine glands and various types of cancers in the skin, bladder, gastrointestinal (particularly the colon), urinary, and reproductive tracts. Some formations, like "polyps" or small growths in the colon and bladder, may be a localized reaction to generalized cell loss and seem to presage local cancer formation (29). Cancers in the fatty and fibrous tissues are also often found scattered throughout the aging body. Malignant growths in the elderly also commonly involve the breasts, lymphoreticular system, and lungs. Although usually not malignant, age-related proliferation of smooth muscle cells in the arteries may contribute to atherosclerosis (47).

Cancerous growths seem to be largely triggered by interactions between noxious agents (e.g., radiation, chemical exposure, and viruses) and characteristics of the host, including genetic factors, hormonal balances, immunological responsiveness, and nutritional status—all of which are more likely to be impaired in the elderly (see ch. 4 and relevant sections of this appendix).

An inherited or acquired genetic component, including a possible age-related decrease in ability to repair mutated and otherwise damaged DNA, may predispose an individual to the birth and spreading of malignant growths. Several "age-accelerating" genetic disorders, like Werner's syndrome, Bloom's syndrome, and xeroderma pigmentosa, involve increased incidence of certain cancers that are suspected to stem from faulty DNA-repair mechanisms.

Altered hormone levels in the elderly have been linked to some cancers: postmenopausal cancer of the uterus has been associated with continued presence of estrogen, both in its natural and ingested forms; increased breast cancer with a rise in prolactin; and increased prostate cancer with the drop in testosterone observed in elderly men.

Finally, the loss of immune function in the elderly (discussed in the following section) may include a decreased ability to detect and kill aberrant or cancerous cells after they have formed, thus facilitating the birth and growth of cancers.

Although these genetic, endocrine, environmental, viral, hormonal, and immunologic factors are all suspect, the relationship between the aging process and the markedly increased incidence of cancer in the elderly compared to the general population remains largely a mystery.

THE AGING IMMUNE SYSTEM

When the body is invaded by a potentially harmful foreign substance, or "antigen," including bacteria and viruses, an immune reaction is triggered. The immune reaction involves the binding and "deactivating" of the antigen by one of two agents present in the blood and body tissues: immune cells (T-lymphocytes or T-cells) produced by the lymph tissue that directly attack the antigen, or proteins in the blood known as antibodies produced by specialized immune cells (B-lymphocytes or B-cells) that are present in the spleen, lymph nodes, and blood.

The T-cell is dependent on the thymus (a ductless glandlike structure found in the neck or upper chest of all vertebrates) and, in addition to its ability to directly "neutralize" antigens, helps regulate the production of antibodies by B-cells. Antibody production is aided by "helper" T-cells and hindered by "suppressor" T-cells. T-cells can also directly kill cancerous, transplanted, or otherwise aberrant cells and are thought to be responsible for cell-mediated or acquired immunity (e.g., the resistance to a specific disease acquired after vaccination).

Aging is accompanied by a marked decrease in the immune system's ability to respond to invasion by harmful substances, as well as an increase in autoimmune reactions (immune reactions to the body's own materials). The B-cells that produce antibodies decrease in number and activity with age. T-cell function exhibits the sharpest decline: direct T-cell attack of antigens decreases with age along with helper T-cell activity, while activity of the suppressor T-cells increases (46,52). As a result, the strength of immune response to infectious agents and aberrant cells is reduced in the elderly.

The aging immune system is also less able to distinguish foreign invaders from native materials, leading to injury of the patient's own tissues by autoimmune reactions (9,42). Age-related deposits of antibody-antigen complexes are often found in organs with extensive capillary beds like the kidneys, lungs, liver, and the brain, and may contribute to localized tissue damage (29,52). There is speculation that rheumatoid arthritis may be due to some type of autoimmune reaction to tissues in the joints.

Age-related morphological changes in the immune system have been associated with the above functional abnormalities seen in the elderly. In particular, the thymus undergoes a progressive decrease in size with age, accompanied by a loss of function. Involution of the thymus begins at puberty and leads to an approximate 85-percent decrease in mass by age 50 in humans (29). In addition, bone marrow is increasingly replaced by fat and fibrous tissue in the elderly, with a general reduction of both immune and red blood cell production in peripheral tissues.

Such age-related decreases in immune function could render the elderly more vulnerable to infectious diseases, including pneumonia and influenza, which remain fourth in leading killers among the elderly today (see app. A), and could contribute to the age-related increase in the prevalence of cancer.

AGE-RELATED CHANGES IN HORMONES

Endocrine glands (e.g., the thyroid, pancreas, pituitary, and testes) tend to shrink with age and exhibit age-related declines in the secretion of some hormones. The sharp drop of estrogen secretion in women during menopause, for example, is well documented. The metabolism of many hormones also declines with age, however, resulting in no net change in the basal levels.

The age-related decrease in function of many hormones could be alternatively explained by an age-related decrease in the effect of some hormones on their target tissues or organs. Glucose intolerance, for example, is more prevalent among the elderly and may be due to a reduction in insulin sensitivity (and therefore reduced ability to metabolize glucose) in peripheral tissues of older persons (11), coupled with an inherited disposition towards the illness. Behavioral changes associated with aging, including an increase in obesity and decrease in exercise, may also contribute to these changes.

This decreased effect of hormones on their target tissues may also provide a basis for age-related changes in presentation of illnesses, response to treatment, and ability to respond to stress. For example, the heart of an older person is generally less responsive to stimulation by catecholamine, a hormone that normally causes the heart to pump harder and faster. As a result, elderly people are less able to maintain adequate blood pressure in response to postural stress or bleeding.

Conclusion

The aging process probably involves a complex interaction of several mechanisms, possibly including both a "biological clock" and accumulated cellular lesions with age. Examination of aging on the cellular level, however, is only part of the integrative approach necessary to a full understanding of the process. Much work remains to be done on the biochemical, cellular, systemic, organismic, and even population levels before a viable theory may be developed to explain why and how people age. Such knowledge could, in turn, lead to medical techniques that prevent or mitigate the symptoms of aging and age-related diseases that afflict many elderly people and drain the Nation's medical and social service resources.

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Appendix C

Nutrition Information

Introduction

Available nutritional surveys of the elderly, although limited and flawed, reveal a low to moderate prevalence and/or increased risk of nutrient deficiencies among both institutionalized and noninstitutionalized groups. Inadequate nutrition may exacerbate many aging processes, including progressive changes in body composition and decline in function of various organ systems. It may also increase the incidence of certain age-related diseases. Evidence is surfacing on the prevalence and effects of long-term "subclinical" deficiencies that produce no immediate symptoms but could induce progressive and subtle changes. Moreover, many elderly exhibit changes with age that can affect their dietary requirements, including altered eating behavior, decreased physical activity, and reduced ability to digest, absorb, and metabolize many nutrients.

Despite increasing amounts of evidence of the importance of adequate nutrition to the physical and mental well-being of the elderly, specific dietary needs of this growing segment of the population remain ill-defined. This has important implications for the Title III Nutrition Program for the Elderly—and especially for the meal and education services.

This appendix reviews the extent and reliability of current information on the nutritional requirements and status of the elderly. Evaluations of the title III programs are also reviewed in order to examine both the efficacy of the programs and the accuracy of the evaluations themselves.

Recommended Dietary Allowances

The Committee on Dietary Allowances (CDA) of the Food and Nutrition Board, part of the National Academy of Sciences, has published a set of Recommended Dietary Allowances (RDAs) every 4 to 6 years since 1943. Their latest estimates were published in 1980. These RDAs specify the minimum levels of intake of essential nutrients needed to maintain normal body function in healthy population groups. The Committee, which consists of 8 to 10 scientists who are chosen as experts in nutrition-related fields, draws on the international scientific literature, including epidemiological and metabolic studies, to determine RDAs.

According to the Committee, intakes below the recommended levels are not necessarily inadequate for all individuals, but they increase the risk of deficiency. For proteins, vitamins, and minerals, the allowances are targeted to meet the needs of 95 percent of individuals within a defined population group (12). Average requirements for these nutrients are first estimated, along with their variability, within the group. These figures are then increased once to meet the needs of almost all of the group members, and once more to compensate for inefficient utilization of consumed nutrients due to, for example, poor digestion or absorption. The energy allowance is meant to be adequate to maintain desirable weight while ensuring adequate nutrition.

RDAs are subdivided by age, sex, height, and weight, and are adjusted to account for special nutritional needs during periods of rapid growth, pregnancy, and lactation. Unfortunately, the elderly are lumped into a 51-and-over age group whose needs are not homogeneous and whose RDAs are essentially extrapolated from survey and research information gathered from younger adults. Except for the vitamins thiamine, riboflavin, and niacin, which are adjusted for males, the recommended nutrient levels are the same for those over 50 as they are for those 23 to 50. The recommended caloric intake is lowered for those over 50 and again for those over 75.

It is generally agreed that changes in metabolism, physical activity, efficacy of organ systems, and body composition that occur in the elderly, along with age-related disabilities and chronic disease, can significantly alter the intake, absorption, and utilization of various nutrients (see following section). RDAs extracted from direct study of the elderly, reflecting what is known about relevant age-related changes, are therefore sorely needed.

Although cost, time factors, and ethical constraints have been barriers to thorough studies of the nutritional requirements and status of the elderly (12), the National Academy of Sciences is planning to launch a study of nutrition and the elderly with an emphasis on what further research is needed to establish accurate age-adjusted RDAs.

Current survey estimates of energy, nutrient intake, and dietary adequacy among the elderly are often flawed by unstandardized methods, errors in estimates of consumption, food table analytical values, and assumptions about absorption of nutrients in the gastrointestinal tract. When short observation periods (1 to 3 days) of food intake are used, the proportions of individuals at both extremes of the distribution are greatly exaggerated because of the large day-to-day variation in intake of many nutrients. Moreover, nutritional surveys of the elderly in the United States have been of very limited scope, lack standards from which to derive comparative frequencies of nutrient deficiencies, and have seldom included individuals over 75.

Ideally, nutritional assessment surveys of dietary adequacy in any population group would be conducted in a three-pronged fashion: quantification of food intake over several days to derive an average daily consumption of energy and major nutrients; measurement of biochemical indices for many nutrients (or their metabolites) in the blood or urine in order to estimate tissue levels; and physical examination of the subjects for clinical evidence of any nutrient deficiencies and for illnesses that may affect nutritional state.

Recent technological advances in assessing nutritional needs include more sensitive and specific biochemical assays (i.e., tests to measure the quantity or activity of a substance) for nutrients in the blood and body tissues, tests of physiological functions related to nutritional status, the development of functional assays for the activity of enzyme systems for which certain vitamins are cofactors, and the analysis of more vital foods for their nutrient content and for how that content may be affected by food processing or preparation.

Without valid standards of adequacy for nutrient intake and tissue levels in the elderly, however, results of even an ideal survey could not be calibrated and would be of limited value. In addition, very little is known about how specific deficiencies, especially long-term subclinical deficiencies for which symptoms may not be immediately apparent, contribute to the aging process.

Age-related physiological and sociological changes affecting nutrition

Age-related factors that affect food intake, digestion, absorption, and/or metabolism include: physiological and biochemical changes accompanied by decline of certain body functions with age; age-related disabilities and disease; drug-nutrient interactions (discussed in ch. 5 of this report); and psychosocial circumstances—including isolation, depression, senile dementia, and lower levels of physical activity.

The human body is known to undergo general changes in composition with age, including a loss of lean body mass (10,13) and an increase in fatty tissue mass (39). The decrease in metabolically active tissue and in physical activity indicates that caloric intake should be cut back. This may increase the risk of nutrient deficiencies, however, which reinforces the need for careful diet management by the elderly. The age-related decline in acuity of taste and smell dulls the pleasure of eating and may further reduce food intake.

The most outwardly apparent age-related changes that affect food intake occur in the mouth. In 1971, about 45 percent of Americans over 65 who were surveyed had no natural teeth (43). Ninety percent of extractions are due to tooth decay or periodontitis. The elderly are particularly susceptible to decay of the roots of the teeth because the gums recede with age, leading to greater exposure of the base of the teeth (an area more susceptible to acid erosion). An added risk factor is age-related decrease in the flow or changes in the composition of the saliva (22).

Intake of starches and simple sugars (e.g., sucrose or table sugar) aggravates decay and increases the risk of loss of teeth (4). Carbohydrates are fermented by oral bacteria to acid that erodes the dental enamel. Impairment of biting and chewing due to lack of teeth or ill-fitting dentures could have a significant influence on the food choices of the elderly. Clinical observations that suggest a high prevalence of vitamin C and B-complex deficiencies in older persons without teeth (17,32) need to be updated and explored further.

Age-related physiological changes in the gastrointestinal (GI) tract may affect food intake, digestion, and absorption. Minor abnormalities in esophageal tract motility (movement in the tube connecting the mouth and stomach) commonly seen in the elderly include disordered contractions and more frequent spontaneous regurgitation of food. In the stomach, age-related changes include decreased hydrochloric acid secretion, decreased intrinsic factor secretion, and decreased pepsinogen secretion (6)—all of which are important to digestion. The absorption of iron and folic acid is known to be acid-sensitive. Diminished hydrochloric acid may also allow overgrowth of bacteria in the small intestine and interfere with absorption.

In the elderly, the villi, or tiny absorptive protrusions in the intestine, are often blunted, and the mucosal surface area of the GI tract lining is reduced. The effects of these histological changes on digestion are as yet unknown.

The elderly often exhibit a decrease in activity of the enzyme lactase, which breaks down the milk sugar lactose in the small intestine. When the absorption of lactose is thus hindered, it moves down the GI tract to the large bowel to be metabolized by bacteria into short-chained fatty acids and various gases. The resulting abdominal discomfort, bloating, and diarrhea may deter the elderly from consuming milk products, contributing to the documented decrease of milk-product intake and difficulty in maintaining adequate calcium in later life. Enzyme additives available over the counter can be used to aid digestion of liquids containing lactose. More research is needed into dairy products in which the lactose has been predigested.

Little is yet known about age-related changes in the absorption of vitamins and minerals, although it appears that the intestine is less able to compensate for low calcium intake in the elderly. More study is also needed on changes in the gut blood vessel circulation that might affect absorption. GI hormone secretion may change with age, affecting the utilization of nutrients and possibly influencing appetite. The constipation that is prevalent among the elderly may also limit food intake.

A progressive reduction in renal function is often observed in the elderly (40) and may affect the homeostatic level of various body substances normally regulated in part by the kidneys. Potentially harmful accumulations of nitrogenous waste from proteins and phosphate due to kidney malfunction are often observed in the elderly and may be treatable by dietary therapy (45).

The incidence of adult-onset noninsulin-dependent diabetes mellitus increases with age. According to one study (46), half the population over 70 would be diagnosed as having diabetes if the criteria used for glucose tolerance in younger people were used. The cause of this age-related decrease in glucose tolerance is unknown, but it obviously has some impact on the recommended diet, including restriction of concentrated simple sugars.

Finally, the psychosocial changes associated with aging may also influence food intake and metabolism. Dementia, isolation, depression, and other emotional stresses can act as appetite suppressants. Social isolation, including living alone, has been shown to correlate positively with poor nutritional status (18,41). Forced or voluntary reduction in physical activity may also limit food intake by reducing appetite and even exacerbate loss of bone mass in the elderly. One study showed that nursing home residents aged 65 to 95 experienced a significant 4.2-percent increase in forearm bone mass after exercising for 30 minutes three times weekly for 3 years, while a control group exhibited a 2.5-percent loss over the same time period (21).

The nutritional status of the elderly

The largest nutrition survey to date was taken in the National Health and Nutrition Examination Survey (HANES, 1971-74). This survey, however, excluded individuals over 74 and presented no authoritative biochemical evidence to correlate with low nutrient intakes or with the presence of clinical symptoms associated with specific deficiencies.

Very few published nutrition surveys recorded the use of vitamin, mineral, or other nutritional supplements. Although their use varies considerably among ethnic groups, such dietary supplements are used by an estimated 40 to 60 percent of the total older population in the United States (14,15,19) and can substantially affect reported nutrient intakes and biochemical indices.

In general, serious or extreme nutritional deficiencies manifesting clinical symptoms are rarely seen among the elderly in the United States. Unfortunately, little information is available on the prevalence of subclinical deficiencies and their possible long-term effects.

Possible connections between nutritional imbalances and aging or age-related diseases are discussed in chapter 4. Many of these connections are tentative as yet. More research is needed to yield conclusive evidence as a basis for diagnosis and treatment of deficiencies.

Food programs for the elderly

In 1980, the rate of deaths due to nutritional deficiencies in the general population was 1 per 100,000 (42). The rates among those over 65 were several times higher (table C-1): 2.4 in the 65 to 74 group, 9.4 in the 75 to 84 group, and 42.9 in the over 85 group. Although reliable figures are not yet available, far greater numbers of elderly may suffer from chronic, though not fatal, malnutrition; the long-term effects on physiological and cognitive functions are only beginning to be understood (see ch. 4).

In 1965, the Federal Government assumed an active role in fighting nutritional deficiencies in the poor with

Table C-1.—Mortality Among the Elderly Due to Nutritional Deficiencies, 1980

Age group	Total number of deaths in age group	Rate (per 100,000 in) specified group	Percent total deaths in age group
65 and over.....	2,060	8.0	0.15
65–75..........	372	2.4	0.08
75–84..........	728	9.4	0.14
85 and over.....	960	42.9	0.27

SOURCE: National Center for Health Statistics, *Advance Report of Final Mortality Statistics, 1980* (42).

the enactment of the Food Stamp Act, then a small-scale program designed to meet what was thought to be a limited need for financial assistance in purchasing food. The Food Stamp Program is now the largest of all food and nutrition programs affecting the non-institutionalized elderly. In fiscal year 1981, for example, an average of 22.4 million people received food stamps each month.

The Administration on Aging (AoA) first sponsored congregate meals for people 60 and over (and their spouses) in 1968 as a research and demonstration project under Title IV of the Older Americans Act Amendment (Public Law 92-258). Nutritional surveys conducted in the early 1970s by the Department of Health, Education, and Welfare (now the Department of Health and Human Services) revealed a substantial prevalence of malnutrition among the poor and the inadequacy of the small-scale Food Stamp Program (1).

In response, Congress expanded the existing food assistance programs and established the Nutrition Program for the Elderly in 1972 in an amendment to the Older Americans Act under Title VII. This congregate meal program was designed to meet the nutritional needs of elderly people who were either unable to buy nutritious food or prepare nutritionally adequate meals, and for these who were isolated and lacked the incentive to prepare meals at home. Another major goal was to attract isolated elderly people to the program centers in order to promote social interaction and facilitate delivery of other services.

Congregate meals under this program are available at least once a day and usually 5 days a week. The meal sites are meant to be strategically located to best provide other supportive services such as outreach, escort and transportation services, health services, information and referral, health and welfare counseling, and nutrition and consumer education.

In 1978, the Older Americans Act was amended (Public Law 95-478) to consolidate the title VII nutrition services and the title V multipurpose senior centers with the social service programs provided under title III. Separate funding was made available to the congregate meal programs to provide home-delivered meals for individuals homebound due to illness, disability, or transportation problems. State agencies distribute funds to area agencies that provide nutritional services within the State. Local providers contract with these area agencies. Federal guidelines suggest that each area agency have a board of directors consisting of local volunteers and senior citizens.

An estimated 1.9 to 2.0 million elderly persons are currently enrolled in the congregate and home-delivered meal programs (36,37).

The Federal Government now sponsors 13 major programs designed to increase the amount and quality of food available to "high risk" segments of the population, including the elderly (table C-2). In fiscal year 1980, $475 million was authorized for the National Nutrition Program for the Elderly ($375 million for congregate meals and $100 million for home-delivered meals). Only $225 million was appropriated. Recent figures show that these funds provided more than 168 million total meals at an average cost of $2.27 per meal (1). These included almost 132 million home-delivered meals for 3,083,454 people over 60.

A total of $676.7 million was appropriated for Older Americans Act programs for fiscal year 1984, including $386.1 million for title III nutrition programs (a $5 million increase over the previous year). Funding levels for State agencies, senior centers, and other supportive services—as well as for title IV research, training, and demonstrations—remained the same (35).

EVALUATION OF FOOD ASSISTANCE PROGRAMS FOR THE ELDERLY

Most evaluations of food assistance programs for the elderly have concentrated on the social and psychological benefits of the meals. The nutritional adequacy of the programs has been evaluated in seven recent surveys: one major national survey contracted by AoA in 1983 (36,37), two area surveys in central Missouri (26,29,30,31) and Maryland (9), and four local evaluations of single meal sites in Nebraska, Colorado, New York, and Illinois (8,16,20,23).

There is considerable variability in the conclusions drawn by these surveys due to differences in how and what kind of information was collected, and how the

Table C-2.—Federal Food Assistance Programs

Department of Agriculture:
Food Stamps[a]
Food Distribution[a]
National School Lunch Program
School Breakfast Program
Child Care Food Program
Special Milk Program
Summer Food Service Program for Children
Special Supplemental Food Program for Women, Infants, and Children (WIC)

Department of Health and Human Services:
Headstart
Nutrition Program for the Elderly[a]
Aid to Families with Dependent Children
Supplemental Security Income[a]

Community Services Administration:
Community Food and Nutrition Program[a]

[a]Most likely to include elderly people.

SOURCE: Aging Health Policy Center, University of California at San Francisco, 1983 (1).

data were analyzed. Certain generalizations about the efficacy of the programs can be made, however.

The surveys generally agreed that the programs were very effective in improving intake of protein. There was disagreement as to whether intake of iron, niacin, thiamine, and vitamins A and C was improved as dramatically. The consensus was that energy and calcium intake were less improved than other nutrients by program meals. Yet intake of almost all of the nutrients surveyed was found to be better overall in participants as compared with both nonparticipants and former participants.

The meals seemed to be reaching varying percentages of the designated target groups. The low-income group was best represented, followed by those over 75. Other target groups, especially minorities and the socially isolated, were less well represented among participants. These underrepresented needy groups may either be ill-informed about the meal programs and nutrition in general or find access to the program difficult.

Problems were also found in the sanitary conditions at program meal sites, especially at those serving catered meals, although conditions varied widely among sites. In addition, the nutrition education mandated by title III was found to be generally insufficient and infrequent at most sites. Furthermore, the nutrition education lectures were often too long—a short (10-minute) talk accompanied by take-home reference pamphlets may be more effective. A general dearth of personnel trained in nutrition and management at the meal sites may contribute to many of these problems.

The above findings and other points raised by the surveys are discussed in greater detail in the following sections. The parameters and limitations of each of the five program surveys are presented in tables C-3 and C-4. Flaws in the surveys that limit their accuracy and comparability are outlined below, including sample selection procedures, method of assessing dietary intake, and data analysis procedures.

Sample Selection.—Only three of the studies—the national, Missouri, and Maryland surveys—appeared to have used randomly and purposively selected samples that were representative of the meal program participants (9,26,29,30,31,36,37). Unfortunately, both the Missouri and New York surveys, though random, were racially homogeneous and did not record income levels (table C-4). Both of these factors are important in characterizing target populations in order to determine whether those in need are actually being reached by the meal programs.

Two of the single-site surveys used volunteers for subjects (16,23). Since volunteers may be more nutritionally aware and generally more involved in the program, this sample selection criterion may further bias the results. Generalizations about the efficacy of food programs cannot be made from nonrepresentative samples; the data they contain are, at best, illustrative. They can provide background data for surveys with appropriate samples.

Assessment of Nutritional Intake and Status.—Only the central Missouri area survey and the single-site evaluations in Colorado and Nebraska (16,20,26,31) attempted to use objective measures of health status, such as biochemical measurements of nutrients in blood and anthropometric measurements (i.e., measurement of height/weight proportions and skin-fold thickness) for detecting problems with weight status. The Missouri survey also used some clinical tests (table C-3). These assessments take into account not only dietary intake but possible problems in the absorption and metabolism of various nutrients that may change with age and with certain age-related diseases.

The subjective measures of dietary intake used by the other surveys, such as 24-hour recall, food diaries (the individual records types and quantities of food consumed over a specified period), and dietary histories (based on recall of the frequency with which certain foods are habitually consumed), are limited in accuracy and usefulness.

Accurate recall of the kinds and amounts of food eaten over a 24-hour period, for example, is difficult for anybody and may be especially difficult for the elderly due to possible memory problems (34). Food diaries are usually more accurate and can be useful if those who review them are trained in food value and nutrition. Often, however, only one day's intake is measured, in which case a large sample size must be used to get a representative estimate for the designated population. Dietary histories can give an estimate of food intake over a longer period of time.

Even such subjective assessments, however, can reveal general trends in the effects of the congregate meal program on nutrient intake, the proportion of the RDA for particular nutrients, and the total day's intake contributed by the meal program (8,9,16,20, 23,26,29,30,31,36,37). These are also economical in terms of the relatively small amount of time and effort needed to obtain the information.

Data Analysis.—Comparisons of data from different food program evaluations can be further complicated by differing procedures for analyzing data, especially dietary intake data. For example, the national evalua-

Table C-3.—Description of Surveys for Evaluating Title III Congregate Meal Programs Funded by the Older Americans Act

Survey	Sample selection	Sample size	N	Parameters measured	Limitations of survey
National (1976, 1981)	**Participants** Purposive	**Participants—** Ate a meal Did not eat a meal	 800 920	**Dietary intake—** 24 hour recall	1. Use of 24-hour recall 2. No biochemical measures 3. No health status measures 4. No anthropometric measurements
	Non-participants Purposive	**Non-participants—** Neighbors	 1,039		
Missouri (1975, 1976, 1979)	**Participants** Random sample of lists of participants	**Participants** Ate a meal Did not eat a meal	 154 213	**Dietary intake—** Food record (1 day) Dietary histories	1. Area sample 2. Only white participants
	Non-participants Subjects most likely to participate in fact did participate 1 year later.	**Non-participants**	99	**Biochemical measures—**Hct, Hb, serum, iron, vitamins B_1, A and C, albumin, cholesterol **Clinical—**Height, weight, triceps skinfold thickness, blood pressure	
Nebraska (1980)	**Participants** Volunteers	**Participants—** Volunteers	 30	**Dietary intake—** 24 hour recall **Biochemical—** Hct, Hb, vitamins B_6, B_{12}, A and C, serum albumin **Anthropometric—** Height, weight, triceps skinfold thickness, arm girth, waist girth	1. Use of 24-hour recall 2. Small sample size 3. No comparison group 4. Local site only 5. Sample selection bias
Colorado (1979)	**Participants** Not stated	**Participants**	59	**Dietary intake—** Food record (1 day)	1. Local site only 2. No anthropometric measures 3. Sample selection bias 4. Cross-sectional survey
	Non-participants Not stated	**Non-participants**	32	**Biochemical—** Hct, Hb, serum protein and albumin, serum vitamins A and C, serum iron, total iron binding capacity	
New York (1979)	**Participants** Random selection from list of participants	**Participants**	73	**Dietary intake—** Food record (1 day)	1. Local site only 2. No biochemical measures 3. No anthropometric measures 4. No comparison group

Table C-3.—Description of Surveys for Evaluating Title III Congregate Meal Programs Funded by the Older Americans Act

Survey	Sample selection	Sample size	N	Parameters measured	Limitations of survey
Maryland (1980)	**Participants** Random selection from 11 site lists	**Participants**	169	**Dietary intake—** Food record (3 days)	1. County sample 2. No biochemical measures 3. No anthropometric measures 4. No comparison group
Illinois (1981)	**Participants** Volunteers **Non-participants—** Volunteers	**Participants** **Non-participants**	8 32	**Dietary intake—** 24 hour recall	1. Local sample 2. Sample size and selection 3. Limited number of nutrients reported 4. No biochemical measures 5. No anthropometric measures

SOURCES: Opinion Research Corp. and Kirschner Associates (1983) (37); Kohrs, O'Hanlon, and Eklund (1978) (29); Kohrs, et al. (1979); Kohrs (1979) (26); Kohrs, et al. (1980) (31); Grandjean, et al. (1981) (16); Harrill, et al. (1981) (20); Callendo (1980) (8); Callendo and Smith (1981) (9); Kim, et al. (1984) (23).

Table C-4.—Description of Subjects and Advantages of Each Nutrition Evaluation Survey

Survey	Race	Income	Advantage
National	Participants 19% minority Non-participants 19% minority	<$6,000—1981 Participants 52% Non-participants 46%	1. National sample and sample size 2. Minorities represented 3. Longitudinal
Missouri	97% White	NA (State guidelines did not permit)	1. Representative sample of area participants 2. Longitudinal 3. Dietary methodology 4. Biochemical evaluation 5. Clinical evaluation 6. Analysis of dietary data provided in meaningful ways 7. Sample size
Nebraska	NS[a]	NS	1. Biochemical measures 2. Anthropometric measurements
Colorado	NS	NS	1. Dietary methodology 2. Biochemical measures
New York	White	NS	1. Analysis of dietary data provided in meaningful ways
Maryland	67% White 30% Black 3% Other	NS	1. Minorities represented 2. Sample size 3. Dietary methodology
Illinois	Korean	NS	1. Minority evaluation

[a] Not stated.

SOURCES: Opinion Research Corp. and Kirschner Associates (1983); Kohrs, O'Hanlon, and Eklund (1978); Kohrs, et al. (1979); Kohrs (1979); Kohrs, et al. (1980); Grandjean, et al. (1981); Harrill, et al. (1981); Callendo (1980); Callendo and Smith (1961); Kim, et al. (1984).

tion presents figures for proportions of people meeting certain dietary intake criteria, while others give mean values for nutrient intake.

Yet both the national and Missouri evaluations offer longitudinal data that are extremely useful in evaluating progress in participants' nutritional status over time.

Conclusions on the Effectiveness of the Food Programs.—*Dietary Intake and Nutritional Status of Participants:* Guidelines for the Federal programs state that a minimum of one-third of the RDAs for specified nutrients should be provided in any meal served to an elderly program participant. The national evaluation reported that those elderly who ate a program meal were more likely to achieve this goal between 11 a.m. and 4 p.m. than those who did not participate (36,37; table C-5). The specified hours are those during which all of the surveyed programs, and a majority of programs in general, serve their meals. Participants were also more likely to meet at least two-thirds of the RDAs over the entire day for the specified nutrients (table C-6). The results for both congregate and home-delivered meals indicated that program meals were most successful at improving dietary intake of protein, B vitamins (riboflavin, niacin, thiamine) and iron (table C-7). This evaluation documented a consistent tie between the program meal and a generally improved diet during the entire 1976 to 1981 evaluation period.

Although the national survey also found that the program meals were less successful at improving intake of other nutrients—such as calcium and vitamins A and C—it could not be determined whether this reflects the nutritional content of the meals served or the food preferences of the participants.

The national evaluation of food service delivery systems used in the title III programs also studied the nutrient content of program meals. Table C-8 compares the results of this evaluation for percentage of RDAs provided by the menus to two other evaluations (25). This study found that for most of the nutrients analyzed, the meals contributed more than one-third of the RDA for participants over 50.

A notable exception was the trace element zinc, of which the menus provided less than one-third of the RDA. The national report failed to note this exception in its discussion. Deficient zinc intake seems to impair immune system function (44) and may be especially detrimental to the elderly, since ability to ward off infection and harmful micro-organisms often declines with age.

This report also compared the estimated values for nutrient content of the meals to values obtained from chemical analyses of the food after cooking (25; table C-9). Chemical analyses are particularly important for nutrients that, like vitamin C, may be destroyed by overcooking and for nutrients about which there is little information available regarding the amount pres-

Table C-5.—Percentage of Elderly Who Consumed 1/3 of Recommended Dietary Allowance During the 11 a.m. - 4 p.m. Period

	Ate a program meal		Did not eat a program meal			
Nutrient[a]	Congregate dining participants	Home-delivered meal recipients	Congregate dining participants	Home-delivered meal recipients	Non-participants	Former participants
	(N = 800)	(N = 340)	(N = 920)	(N = 63)	(N = 1,039)	(N = 249)
Calcium	51%	50%	26%	30%	25%	25%
Vitamin A	55	50	28	32	26	26
Vitamin C	59	52	36	44	34	36
Thiamine	70	67	54	49	52	54
Niacin	73	66	52	46	49	46
Iron	75	67	46	51	44	40
Riboflavin	78	75	57	54	56	55
Protein	87	83	64	63	60	58
Calories	53	48	35	30	32	31

[a] Elderly persons who ate a program meal were significantly more likely to meet ⅓ RDA for each nutrient (all x^2, 1df, 90.0, all p's <0.01) (36).

SOURCES: Opinion Research Corporation and Kirschner Associates (1983).

Table C-6.—Percentage of Elderly Meeting at Least 2/3 of Recommended Dietary Allowance (RDA) for Key Nutrients During Wave I and Wave II

	Wave II (Wave I in Parentheses)[a]					
	Congregate dining participants		Home-delivered meal recipients			
Nutrient[b]	Ate a site meal yesterday	Did not eat a site meal yesterday	Ate a program meal yesterday	Did not eat a program meal yesterday	Non-partici-pating neighbors	Former partici-pants
	N = 800 (N = 765)	N = 920 (N = 1,049)	N = 340 (N = 0)	N = 63 (N = 0)	N = 1,039 (N = 1,788)	N = 249 (N = 0)
Calcium	64% (67%)	46% (49%)	58%	41%	47% (47%)	49%
Vitamin A	70 (69)	50 (56)	64	46	55 (53)	51
Vitamin C	79 (81)	72 (73)	73	75	71 (70)	67
Thiamine[c]	92 (79)	86 (74)	90	83	87 (71)	89
Niacin[c]	86 (81)	79 (75)	81	68	80 (72)	79
Iron	84 (86)	74 (77)	79	63	77 (76)	78
Riboflavin[c]	95 (89)	88 (79)	94	83	88 (79)	90
Protein	96 (96)	90 (91)	95	90	90 (90)	92
Calories	70 (73)	63 (68)	64	48	63 (63)	63

[a] Dietary intake was not assessed for home-delivered meal recipients and former participants during Wave I.

[b] Discriminant analysis revealed that having eaten a congregate or home-delivered meal was significantly related to better overall diet scores (univariate F for congregate meal participants, df = 1 and 741, = 27.7, $p < 0.01$; univariate F for home-delivered meal recipients, df = 1 and 123, = 11.5, $p < 0.01$).

[c] The wave-to-wave increases in intake of these nutrients may be strongly related to 25 to 50 percent increases in food nutrient enrichment levels that took effect for these nutrients since Wave I while RDAs for these nutrients have changed little.

SOURCES: Opinion Research Corp. and Kirschner Associates (1963) (36).

Table C-7.—Percent of Total Day's Nutrient Intake Supplied by Title III Meal

	Meal Program					
	Missouri[a]		Colorado[b]		New York[c]	
Nutrient	Men	Women	Men	Women	Both sexes	Range
Energy	46.4%*	52.4%*	41 ± 3%	48 ± 2%	45 ± 3%	29–72%
Protein	47.5*	55.1*	54 ± 3	59 ± 2	51 ± 2	22–86
Calcium	42.4	45.2	48 ± 4*	61 ± 3*	44 ± 3	12-91
Iron	41.6*	46.7*	46 ± 3	52 ± 2	48 ± 3	12–79
Vitamin A	50.5	52.6	49 ± 5	59 ± 3	57 ± 4	19–70
Thiamine	38.8	42.2	39 ± 3	42 ± 2	48 ± 3	18–90
Riboflavin	41.4	44.4	50 ± 3	56 ± 2	47 ± 2	12–94
Niacin	45.6*	53.0*	53 ± 4	54 ± 2	52 ± 2	2–94
Vitamin C	48.4	46.3	36 ± 5	44 ± 4	48 ± 4	10–95

[a] Based on 54 men and 100 women.

[b] Based on 14 men and 45 women.

[c] Based on 53 subjects of both sexes.

*Differences between men and women are statistically significant for the survey ($p < 0.05$).

SOURCES: Kohrs, O'Hanlon, and Eklund (1978) (29); Kohrs, et al. (1980) (31); Harrill, et al. (1981) (20); Caliendo (1980) (8).

Table C-8.—Mean Percentages of Recommended Dietary Allowances (RDAs) Provided by Meals Served at Congregate Meal Sites (mean ± standard error)

	Area served by meals					
	National[a]		Missouri[b]		Colorado[c]	
Nutrient	Men	Women	Men	Women	Men	Women
Protein	66 ± 1%	84 ± 2%	75 ± 3%	91 ± 4%	81 ± 12%	99 ± 14%
Calcium	61 ± 2	61 ± 2	65 ± 3	65 ± 3	60 ± 3	60 ± 3
Iron	51 ± 1	51 ± 1	53 ± 3	53 ± 3	62 ± 7	62 ± 7
Vitamin A	106 ± 10	133 ± 12	70 ± 12	87 ± 15	72 ± 28	90 ± 35
Thiamine	34 ± 1	48 ± 1	41 ± 4	49 ± 5	36 ± 1	43 ± 2
Riboflavin	64 ± 5	71 ± 3	63 ± 3	86 ± 3	61 ± 4	83 ± 4
Niacin	49 ± 1	57 ± 2	40 ± 3	54 ± 3	65 ± 10	86 ± 13
Vitamin C	73 ± 3	73 ± 3	83 ± 13	83 ± 13	52 ± 4	52 ± 4
Zinc	24 ± 1	24 ± 1	—	—	—	—

[a] Based on 117 meals from selected sites representative of each region and the United States.
[b] Based on 20 menus served during survey days at 5 sites.
[c] Based on 5 meals served at site during survey.

NOTE: CAUTION NEEDS TO BE EXERTED IN USING SUCH VALUES BECAUSE NUTRIENTS MAY HAVE BEEN LOST OR DESTROYED DURING COOKING PROCESS. THESE RESULTS ARE ALSO BASED ON THE ASSUMPTION THAT THERE IS ADEQUATE PORTION CONTROL.

SOURCES: Opinion Research Corporation and Kirschner Associates (1983) (37); Kohrs, O'Hanlon, and Eklund (1978) (29); Harrill, et al. (1981) (20).

Table C-9.—Comparison of Analyzed and Calculated Percentage of Recommended Dietary Allowance (RDA) Values in Meals Served to the Elderly (± standard error)

	Analyzed		Calculated	
Nutrient	Men	Women	Men	Women
Protein	70 ± 2%	90 ± 2%	65 ± 2%	83 ± 2%
Calcium	53 ± 2	53 ± 2	59 ± 2	59 ± 2
Vitamin A	62 ± 6	78 ± 8	112 ± 20	140 ± 24
Thiamine	40 ± 4	56 ± 6	34 ± 1	48 ± 2
Riboflavin	51 ± 2	60 ± 6	64 ± 5	75 ± 6
Vitamin C	20 ± 2	19 ± 2[a]	67 ± 6	67 ± 6
Zinc	29 ± 2[a]	29 ± 2[a]	24 ± 1[a]	24 ± 1[a]

[a] Less than one-third of the RDA.

SOURCES: Opinion Research Corporation and Kirschner Associates (1983) (37).

ent in certain foods (e.g., folic acid or zinc) (3,7,44). More such chemical analyses would enhance the accuracy of these kinds of evaluations.

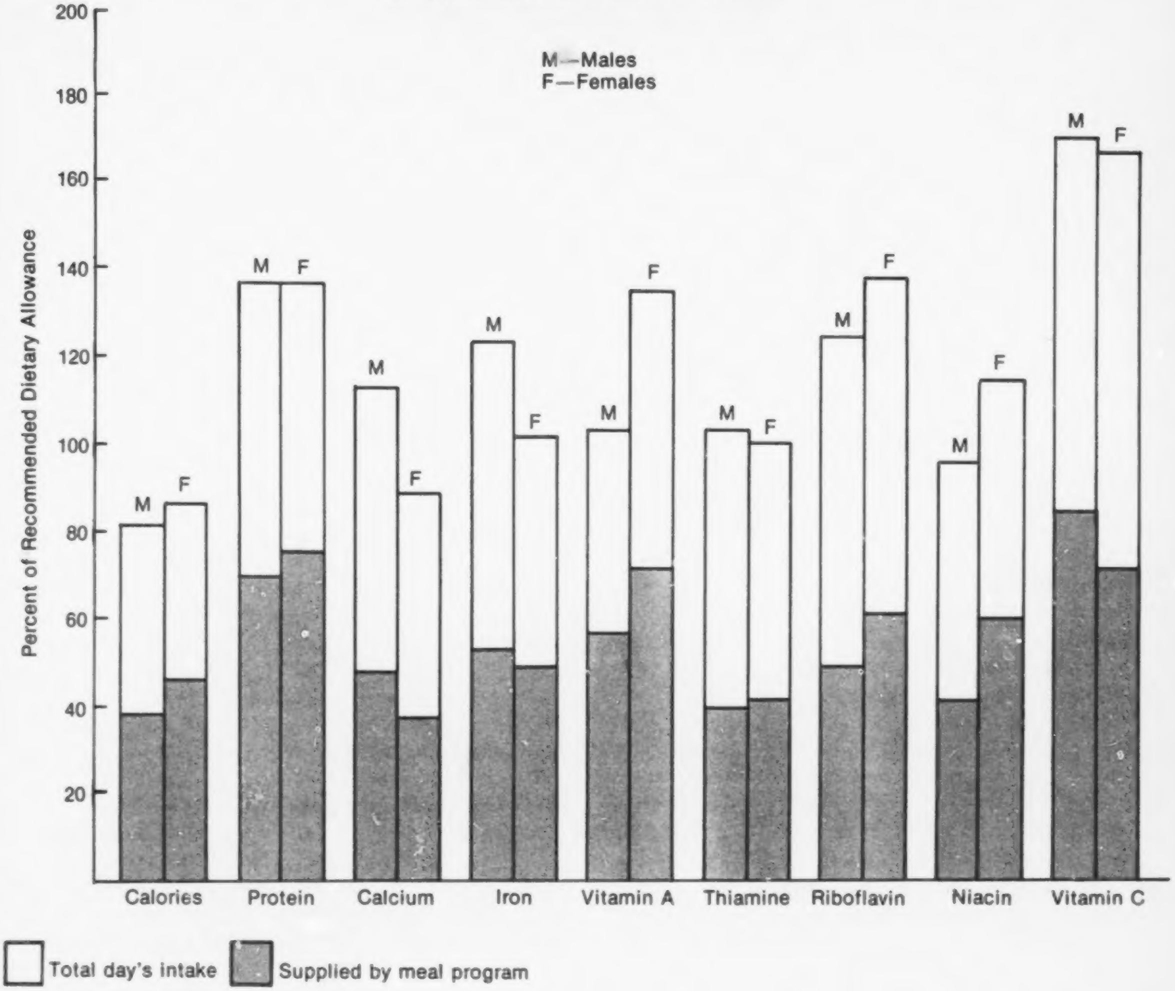
In the Missouri evaluation, the total day's dietary intake of nutrients reflected the nutritional content of the program meal (26,29; see fig. C-1). The nutrients provided in the greatest amount by the program menu—protein and vitamins A and C—were also consumed in the greatest amount. Nutrients that were provided in smaller proportions of the RDA in the meals—energy and niacin for men and thiamine for both sexes—were those for which the total daily consumption was less than 100 percent of the RDA (fig. C-1). These results from food records were reinforced by data from dietary histories and blood sample analyses (27,28,31).

People who participated regularly in the Missouri program reduced their risk for clinical deficiencies of vitamins A and C. These results were strengthened by longitudinal data; fewer incidences of low serum values for these vitamins were recorded after 1 year in the program, and none were found after 4 years of participation (27,28; table C-10). In contrast, no improvement was seen in risks for anemia, especially iron-deficiency anemia, in terms of dietary intake or serum hemoglobin and iron (26,27,28,31).

There is a risk of increasing intake of foods high in saturated fats and cholesterol (like red meat) when providing meals high in energy, protein, and calcium. The Missouri evaluation, however, found no evidence of either elevated intake of these substances or of obesity (another risk factor for cardiovascular disease) among regular participants who ate program meals two to five times a week (27,31).

Percent of Total Day's Intake Provided by Meal: The proportion of the total day's nutrient intake provided by the program meal was evaluated by the Missouri and the single-site surveys in Colorado and New York. All three evaluations (8,20,29) indicated that a substantial proportion of the total day's intake was consumed

Figure C-1.—One-Day Intake of Nutrients by Participants Eating at the Meal Program, Expressed as Percentage of Recommended Dietary Allowance



SOURCE: Kohrs, O'Hanlon, and Eklund (1978), (29).

Table C-10.—Percentages of Participants at One Site Who Had Low Concentrations for Serum Vitamins A and C,[a] According to Year Blood Samples Were Taken

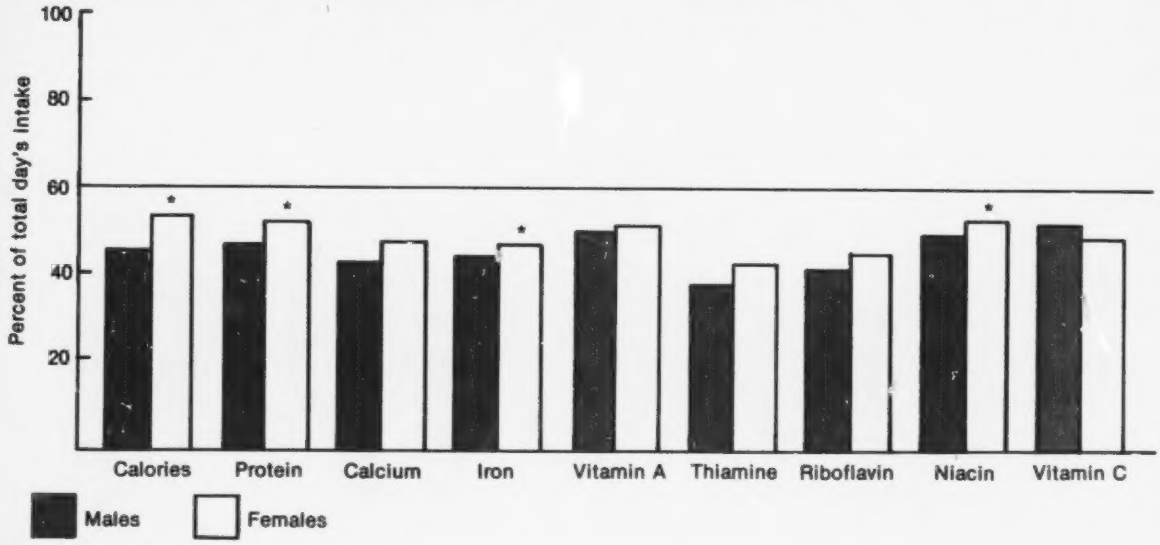
Year	Serum vitamin A	Serum vitamin C
1975	43%	7%
1976	13	2
1979	0	0

[a] Low concentrations for vitamins A and C were < 20 ug/100 ml and < 0.2 mg/100 ml, respectively.

SOURCE: Kohrs (1982), (27).

during the program meal. All indicated that an average of 40 percent or more of the total daily nutrient intake (not the RDA) for each individual was consumed during the meal (table C-7). The results of the other two surveys are similar to those from Missouri (fig. C-2). In some cases, an average of 60 percent of the total day's nutrient intake was provided by the program meal (table C-7). In Missouri, the program meal supplied a larger average proportion of the total day's intake of energy, protein, iron, and thiamine to women than to men.

Figure C-2.—Percent of Total Day's Intake of Nutrients Furnished by the Meal Program, for Males and Females



* Significantly different ($p<0.05$)

SOURCE: Kohrs (1982), (27).

These results suggest that a large number of participants in the three programs depend on the program meal for much of their daily food intake. Ironically, those participants whose major nutritional source is the program meal are probably more at risk for deficiencies since, even if the meal provides its mandated 33 percent of the RDA for most nutrients, their total daily intake would be well below the RDA.

The values for the New York evaluation reflect the great variability underlying these data (table C-7). For some participants in the New York program, the meal provided more than 75 percent of their day's intake of protein, iron, calcium, riboflavin, niacin, thiamine, and vitamin C. If the meal in fact provided only 33 percent of the RDA for these nutrients, these participants could be consuming less than half of the RDA per day. Yet some received 12 percent or less of their daily intake for many of these nutrients in the meal and thus would be more likely to meet the RDA by supplementing their diet outside of the program.

Participants v. Nonparticipants: The national, Missouri, and Colorado surveys all compared the nutrient intake of participants with that of nonparticipants. All three found that intake of vitamins and minerals was significantly increased by participation in the title III congregate meal program (20,29,36,37). The national survey used 24-hour recall; the other two surveys used food records.

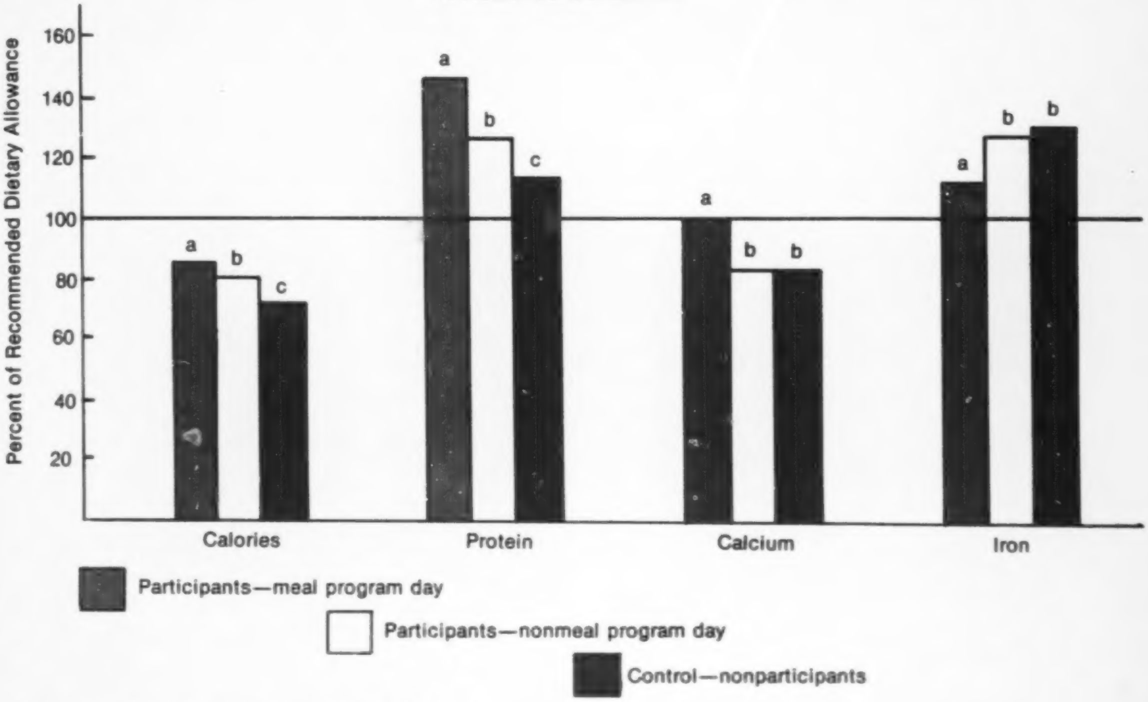
These three surveys and another evaluation of elderly Koreans participating in the meal program (23) all found that the program significantly increased calcium intake, one of the major nutrients frequently lacking in the diets of older women and implicated in hypertension and osteoporosis.

The Missouri survey revealed that intakes of energy and protein were greater for the participants who ate the program meal than for both nonparticipants and participants who did not eat a program meal on the day of the food record (fig. C-3). The national survey demonstrated that the energy intake for women under age 76 who ate the program meal was proportionally greater than that of women who did not participate.

Moreover, the energy and protein intake of those participants not involved on a particular day was still higher than that of the control group (nonparticipants) in Missouri. This finding suggests that other services such as transportation, shopping assistance, and nutrition education contribute to improved intake for participants even when not eating at the program, and that partial savings by eating program meals may be used to buy more and better food.

In Colorado, the survey found that intake of several other nutrients, including fat and some of the B vitamins (thiamine, riboflavin, and niacin), was greater for participants than for nonparticipants. Biochemical evidence of iron-deficiency anemia, found in a small

Figure C-3.—Influence of Meal Program Participation Status on Percentage of Recommended Dietary Allowance Consumed[a]



[a] Bars with different letters (a,b,c) are significantly different ($p<0.05$).

SOURCE: Kohrs, O'Hanlon, and Eklund (1978), (29).

number of participants and nonparticipants in Colorado (20), was more common among the nonparticipants.

The national evaluation further reported that overall intake of energy and eight nutrients was greater for participants in comparison with nonparticipants, former participants, and those who did not eat the meal that day (table C-6). The report suggests that improvement in dietary intake is a function of actually *consuming* the program meal rather than simply being enrolled in either congregate or home-delivery services (36,37).

Correlation of Nutritional Status With Sex, Age, Race, and Income: The Nutrition Program for Older Americans is mandated to help meet the needs of those who are poor, socially isolated, over 75, members of an ethnic minority, limited in ability to speak English, and/or have a mobility impairment. A profile of participants in both the congregate and home-delivered meal programs, as well as former participants and nonparticipating neighbors, is given in table C-11. The low-income and over-75 target groups appear to have higher proportions who are program participants, with those who suffer mobility impairment predictably composing most of the home-delivered meal recipients. Other groups, however, comprise markedly lower proportions of all participants—including minorities, those who are socially isolated, and especially those whose English is limited (table C-11). This could be due to lack of awareness or inaccessibility of the program among these groups.

Other demographic variables of interest are presented in table C-12. Recipients of home-delivered meals were generally older, poorer (65 percent had incomes below $6,000 in 1981), and in poorer health than the congregate meal recipients. The national evaluation concluded that congregate-meal participants qualifying as "priority" recipients due to advanced age, low income, minority status, isolation, mobility impairment, or lack of fluency in English aggregately constitute three-quarters of all congregate participants (36,37).

On average, participants are getting older—one-third of participants were over 75 in 1978 compared with 41 percent of congregate participants and two-thirds of home-delivered meal recipients in 1982. Interest-

Table C-11.—Percentage of Survey Respondents With Specific Priority Traits

	Priority traits					
	Low income[a]	Minority status	Social isolation	Mobility impairment	Limited ability to speak English	Advanced age[b]
Home-delivered meal recipients (N = 415)	65%	15%	19%	72%	2%	67%
Former participants (N = 249)	61	14	17	22	—[c]	59
Congregate participants (N = 1,735)	52	19	17	11	2	41
Non-participating neighbors (N = 1,039)	46	18	15	17	1	40

[a] Below $6,000 annual 1981 income.
[b] 75 years of age or older.
[c] Denotes less than 1 percent.

SOURCES: Opinion Research Corporation and Kirschner Associates (1983), (36).

Table C-12.—Selected Characteristics of Congregate Meal Participants and Home-Delivered Meal Recipients

Characteristic	Congregate participants	Home-delivered meal recipients
	(N = 1,735)	(N = 415)
Average age (in years)	73	78
Live alone	55%	61%
1981 family income below $6,000	52	65
Income takes care of needs only "poorly"	16	24
Household receives food stamps	13	19
Receives Medicaid benefits	18	30
Get out of house nearly every day	81	24[a]
Able to clean and maintain home by themselves	89	41[a]
Fair or poor current health	25	59[a]
Health worse than last year	16	38
Spent time in hospital/nursing home in past year	23	44[a]
Rarely or never attend religious services	24	63[a]
Never invite others to eat at their homes	23	66[a]

[a] Discriminant function analysis revealed that these variables maximally discriminate between the two groups. All univariate F values > 65.0, all p's < 0.01 (df = 1 and 1,208).

SOURCES: Opinion Research Corp. and Kirschner Associates (1983), (36).

ingly, the average annual income of participants is also rising and is more evenly distributed in the $9,999 and under group with fewer participants earning less than $4,000 a year (table C-13).

Results of both the national and Missouri evaluations for dietary intake indicated that at least some of the program's target groups benefited (30,36,37). The Missouri evaluation found that participants over 75 consumed a larger proportion of their total daily intake of calories and vitamin A than did younger participants.

The national evaluation found income to be significantly related to dietary intake among congregate and home-delivered meal participants as well as nonparticipants (36,37). Among persons receiving less than $6,000 annually, a greater proportion of those who ate a program meal consumed the minimum recommended amounts of calcium, vitamin A, and calories than those who did not participate (table C-14). Eating a program meal significantly reduced income-related intake differences for calcium and calories.

Although the Missouri evaluation did not indicate income, it did conclude that the meal program ameliorated the differences in nutrient intake found to be related to level of education and pre-retirement occupation (26,30; fig. C-4 and C-5). In fact, education, pre-retirement occupation, and marital status were not shown to be related to the RDA-proportion of nutrients consumed by those who ate the program meal on the day of the food record. In contrast, such socioeconomic factors were significantly related to intakes

Table C-13.—Income Distribution of Respondents During Wave I and Wave II, 1975 and 1981

	Wave II (Wave I in parentheses)				
	Participants				
Annual family income[a]	Total	Longer term	Recent entrants	Home-delivered meal recipients	Non-partici-pating neighbors
	N = 1,735 (N = 2,803)	N = 878 (N = 972)	N = 857 (N = 1,831)	N = 415 (N = 0)	N = 1,037 (N = 1,797)
Less than $2,000	3% (19%)	3% (22%)	4% (17%)	7% (N.A.)[d]	3% (15%)
$2,000–$3,999	23 (47)	26 (50)	20 (45)	31 (N.A.)	21 (40)
$4,000–$5,999	26 (17)	26 (14)	26 (19)	27 (N.A.)	22 (19)
$6,000–$9,999	23 (11)	22 (10)	24 (12)	24 (N.A.)	22 (14)
$10,000–$13,999 ($10,000 or more)[b]	10 (5)	10 (3)	10 (6)	5 (N.A.)	13 (11)
$14,000–$17,999	6	5	7	1 (N.A.)	6
$18,000–$21,999	2	2	2	—[c] (N.A.)	3
$22,000 or more	3	2	3	1 (N.A.)	6
Refused/no response	4 (1)	4 (1)	4 (1)	4 (N.A.)	4 (1)
Total	100 (100)	100 (100)	100 (100)	100 (N.A.)	100 (100)

[a] Wave I data reflect self-reported or estimated annual family income for 1975. Wave II data reflect self-reported or estimated annual family income for 1981.

[b] "$10,000 or more" was the highest income category used during Wave I.

[c] Denotes less than 1 percent.

[d] Not assessed.

SOURCES: Opinion Research Corp. and Kirschner Associates (1983), (36).

Table C-14.—Relationship Among Daily Dietary Intake of Low Intake Nutrients, Nutrition Program Participation, and 1981 Family Income

	Ate a program meal		Did not eat a program meal[a]	
Met or exceeded two-thirds RDA[b]	Below $6,000	$6,000 or more	Below $6,000	$6,000 or more
	(N = 678)	(N = 409)	(N = 1,107)	(N = 1,077)
Calcium	61%	63%	42%	51%
Vitamin A	65	74	46	54
Calories	73	78	62	73

[a] Includes all respondents who did not eat a program meal (i.e. participants, home-delivered meal recipients, nonparticipants and former participants).

[b] Among those who did not eat a program meal, income was significantly related to higher intake for each nutrient (all x^2, 1 df, >5.4, all p's <0.01).
Among those who consumed a program meal, income was significantly related to higher intake of vitamin A (x^2, 1 df $= 7.9$, $p < 0.01$), but not for calcium or calories (all x^2, 1 df, <2.9, all p's >0.05).

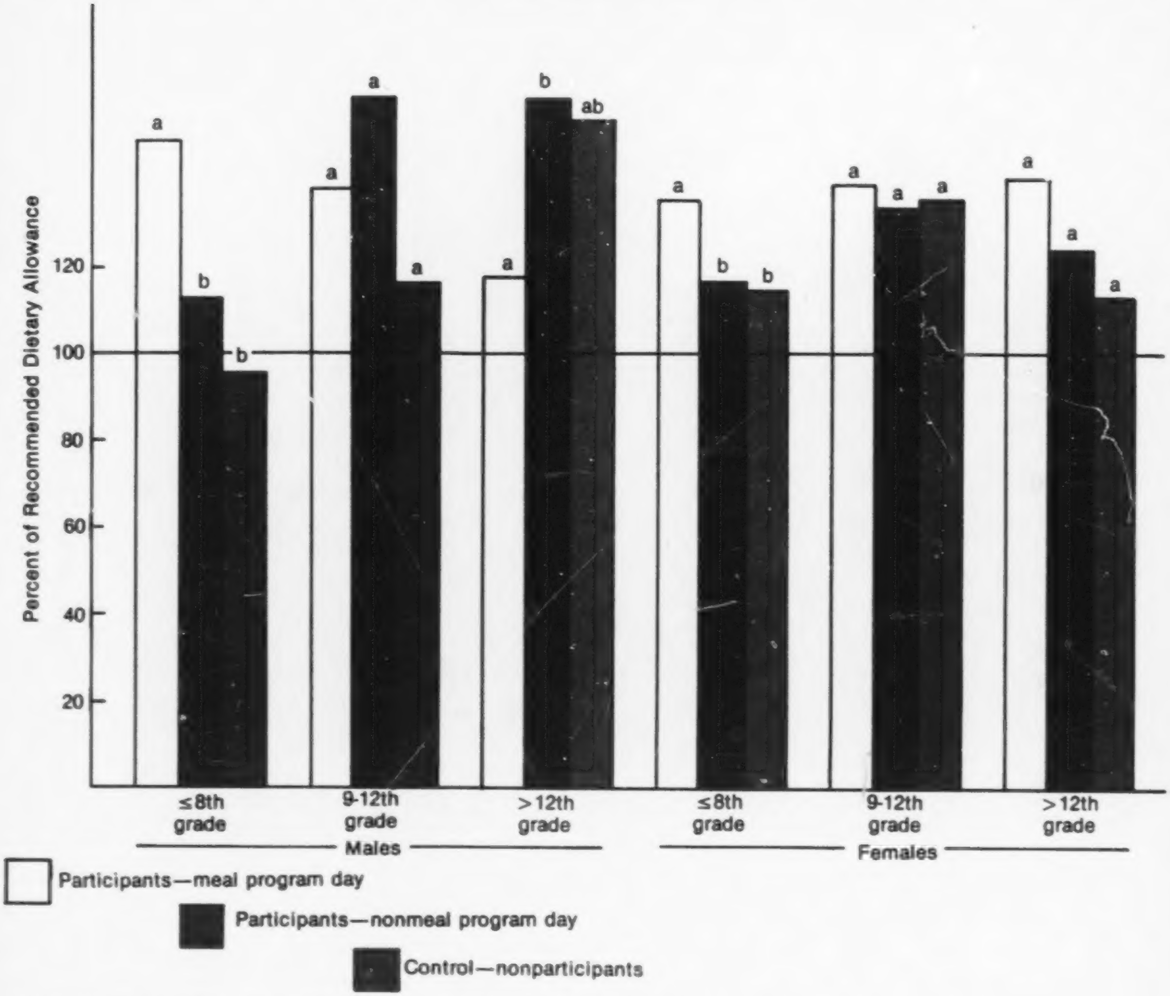
SOURCES: Opinion Research Corp. and Kirschner Associates (1983), (36).

of calories and seven nutrients among the participants who did not eat the meal program that day and also to the intake of six nutrients among nonparticipants (figs. C-4 and C-5).

In general, using dietary intake as a measurement for meeting the nutritional goals of the title III program, the national and Missouri evaluations found that people with lower socioeconomic status benefited the most by eating the program meal.

Nutrition Education: The title III program is mandated to provide nutritional education as one of the services associated with the meal program. The national evaluation reported that at most sites nutrition education classes were generally offered less than once a month (36,37). Site managers reported that benefits of nutrition education could be augmented by increasing the frequency of the classes and by improving the qualifications of the teaching personnel.

Figure C-4.—Influence of Group, on Percentage of Recommended Dietary Allowance for Protein,[a] by Sex and Education



[a] Bars with different letters (a,b,c) are significantly different ($p<0.05$) within each education group.

SOURCES: Kohrs, et al. (1979), (30).

Nutrition instruction is useful in that it helps individuals to shop and prepare nutritious foods in an economical way. The cost effectiveness of providing nutrition education by registered dietitians and trained nutritionists in terms of health costs averted and fewer dependents on the meal program has not yet been evaluated.

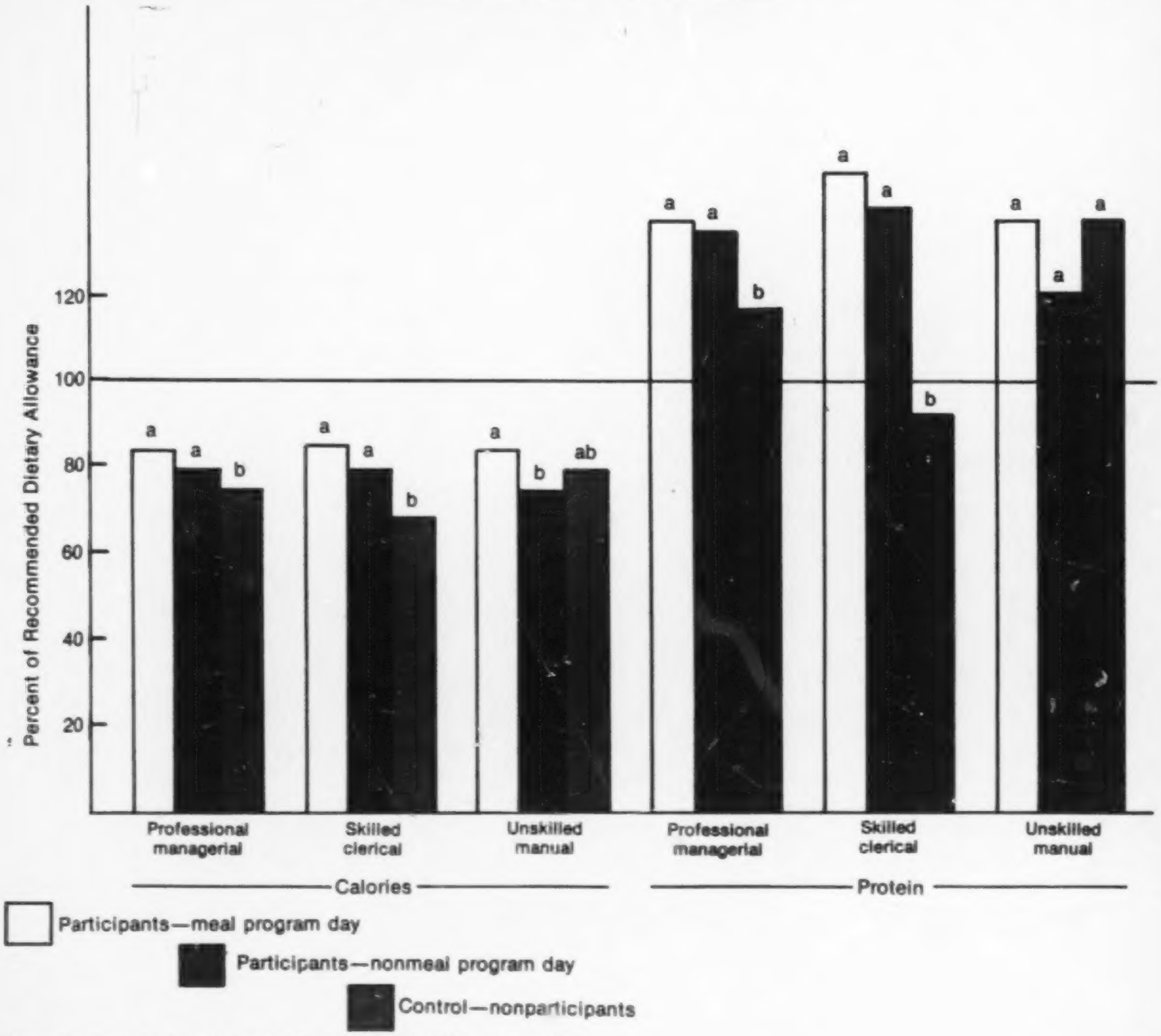
A pilot program in Missouri found not only that older people were interested in participating in nutrition education classes, but that those who attended a program regularly for 5 out of 10 classes increased their knowledge of good nutrition (27,28). The effect on dietary intake, however, was not evaluated.

In general, the nutrition classes tend to be too long. A 10-minute lecture accompanied by take-home nutritional guides may be more effective.

Participants' Perception of Program Benefits: The national evaluation and an evaluation in Boston both studied the participants' perceptions of the meal program.

The national evaluation found that people enrolled in the program reported that participation may help

Figure C-5.—Influence of Meal Program Participation Status on Percentage of Recommended Dietary Allowance for Calories and Protein, by Occupation[a]



[a]Bars with different letters (a,b,c) are significantly different within each occupation.

SOURCE: Kohrs, et al. (1979), (30).

to keep them mobile. Those who remained active in the program from the beginning of the survey in 1975 reported more mobility than did respondents who either left the program or never enrolled. The national evaluation also reported that when age, minority status, sex, and self-reported health were controlled, program benefits were not apparent in terms of increased longevity. Even so, the evaluation asserted, participation itself may help sustain the quality of life by enhancing social activity and maintenance of positive self-perceptions of health status (36,37).

The Boston evaluation attempted to determine the participants' perceptions in terms of their personal goals and the programs' value to them (38). The participants most valued the setting for the congregate meal, the recreational and social activities, and the financial relief. Most of the participants (81 percent) indicated that the program was achieving all of the following goals: provision of the meal, increased opportunities for socialization, and better health through improved nutrition.

The greatest impact of the Boston program was found to be in the financial, social, and recreational areas. Even though the participants felt that the program was meeting the goal of improved health through nutrition, fewer than 5 percent reported that the program affected their diet or health. The Boston study concluded that those with more frequent patterns of participation and those with greater need for financial assistance reported significantly greater effects on monetary savings, food preparation practices, food consumption, and food purchasing behavior (38).

Nutrition, Cost, Sanitation, and Acceptance of Different Food Delivery Systems: By 1982, the number of congregate meal sites was about 13,500, more than twice the total of 6,700 in 1976. The number of meals served per day also doubled during that period, rising to approximately 800,000 congregate and home-delivered meals in 1982. Although the prevalence of home-delivered meals did not change from 1976 to 1982 (most programs offer them), the average number of home-delivered meals served daily per site doubled, and the proportion of home-delivered meals relative to all meals being served tripled. Currently, about 175,000 title III meals are being home-delivered daily within the contiguous States, constituting about 22 percent of all title III meals (36,37).

Nutrition: The clearest comparison of the nutritional effectiveness of congregate v. home-delivered meals is presented in the national evaluation (table C-5). Intake of all nutrients measured was consistently lower for home-delivered meal recipients. The national evaluation attributes this, at least partly, to the home recipients' poorer health status and greater difficulty in chewing (36,37). The greater isolation and related depression to which the homebound are especially vulnerable may also inhibit intake.

The congregate and home-delivered meals were identical in 80 percent of the sites—any differences were attributable to transportation constraints or to the different dietary needs of the homebound recipients who are more likely to need low-salt, low-sugar, or low-fat meals. The national survey also concluded that the recipients of home-delivered meals benefited more than congregate participants, since the former showed lower intakes for most nutrients on non-meal program days (36,37).

Cost: A study of food delivery systems in the title III programs for the elderly looked at four factors that could theoretically influence cost of the meals: meal preparation systems (i.e., catered v. onsite preparation), project size, urban v. rural setting, and region. Project size was the only factor found to be related to cost (25). The slightly lower costs per meal achieved by larger projects were not a result of lower food and food service costs but of lower cost for support activities like administration, outreach, and nutrition education. Statistical analysis of the relationship between the cost and the quality of the meals found that the two were unrelated.

The average cost per meal was calculated to be $4.08 by a later national study. Although figures were not provided, a major problem with home-delivery service is that funding is inadequate to meet demand. According to area directors, only 52 percent of the elderly people who need home-delivered meals in the United States are receiving them. Home-delivered meals are usually prepared at or distributed through the congregate meal sites (36,37). Additional cost may be incurred, however, in providing delivery equipment and personnel.

Sanitation: A local evaluation in Ohio (24) studied the sanitary conditions and acceptance of onsite-prepared v. catered meals in the title III program. Analyses of the meals for microbial contamination indicated that onsite preparation was generally more sanitary than catering.

Meal safety was also assessed in the 1981 national study (25) through sanitary inspections of meal sites and microbiological analyses of the meals themselves. Results varied widely among sites, some of which were found to be deficient in their sanitary practices. Although this study did not evaluate the administrative personnel of the meal programs, it suggested that food programs would benefit by utilizing registered dietitians to improve sanitation and food management in general. Such dietitians are trained not only to regulate the nutritional content and sanitary conditions of the meals but to ensure optimum preservation of nutrients in food preparation and cost-effective food management.

In a nationwide study of food delivery systems and technologies commissioned by the AoA with the American Dietetic Association, a major finding was that service regulations failed to designate qualified personnel to plan, manage, and evaluate nutrition services (33). Other problems identified included a lack of detailed food specifications on food products, equipment, packaging, and delivery practices for both congregate and home-delivered meals. Also cited as concerns were: maintenance of food temperature during transportation; a reliance on untrained volunteers to deliver meals and services; variable food portion control; limited space for food preparation and delivery; safety and sanitation hazards; and a limited number of certified management personnel.

Many of the staff and food management problems cited in the above studies could be addressed by instituting standard regulations for food programs mandating the employment of registered dietitians at meal program sites. The national evaluation did not analyze whether or how registered dietitians are used. One of the most frequent complaints of State and area program directors reported in this study, however, concerned the low quality of the staff. Most of the local directors (71 percent) said that additional training in fiscal, personnel, and food management, as well as gerontology, would improve nutrition program operations (36,37).

The national evaluation reviewed the educational levels of certain management personnel, including those called "nutritionists/dietitians." It is probable that many people so designated are not registered dietitians, since 7 percent did not finish college; this figure jumps to 11 percent for area agency directors, 39 percent for "nutrition directors," and 83 percent for "site managers" (36,37). Registered dietitians must have a college degree with additional on-the-job experience and must have been accepted into the American Dietetic Association. A nutritionist is required to have still more training and usually also holds an advanced degree.

Acceptance: Expert tasting panels were used in the local Ohio study to assess the taste and esthetic quality of the meals. Onsite-prepared meals were found to be of superior quality and greater in quantity than catered meals (24). Ratings for acceptance and food quality were low for both types of meal preparations; however, only 36 out of 501 respondents indicated that they enjoyed the food served at the meal sites. This clearly indicates a need for revised content and preparation of the meals.

FOOD STAMP PROGRAM PARTICIPATION

The Food Stamp Program is the largest of all food and nutrition programs affecting the noninstitutionalized elderly. The degree of participation and the factors determining participation in the Food Stamp Program (FSP) have been evaluated in two studies. One was based on the National Food Consumption Surveys of low-income households conducted in the periods 1977-78 and 1979-80 (2), and the other was an evaluation of a local food stamp cashout demonstration (5).

The national study found that about 50 percent of eligible elderly households participated in 1979-80, as opposed to less than 40 percent in the earlier period (2). Participation increased at about the same rate among whites and blacks. This increase in participation could be due largely to elimination of the purchase requirement in January 1979. There has been recent speculation, however, that the expanding FSP is still not reaching the most needy (38). Correlation of demographic variables with participation can help reveal factors affecting the decision to participate and thus help generate policies or regulations that would encourage participation of the most needy population groups.

Significant influence of several variables on FSP participation was found in both the 1977-78 and 1979-80 periods. Participation at every income level among those eligible rose by 10 to 15 percent in the later survey, although figures for the lower income groups and younger age groups were consistently higher in both time periods (2,5; figs. C-6 to C-9). The proportion of the poorest households (those below poverty level) participating rose from about 33 percent in 1977-78 to 60 percent in 1979-80 (2). Interestingly, estimates of participation in elderly feeding programs (including congregate and home-delivered meals) dropped, while overlap between these and the FSP seemed to rise (tables C-15 and C-16). Since there was no change in sampling criteria to allow for tightening of eligibility requirements in 1979, FSP participation among the relatively smaller eligible group in 1979-80 may in fact have been underestimated.

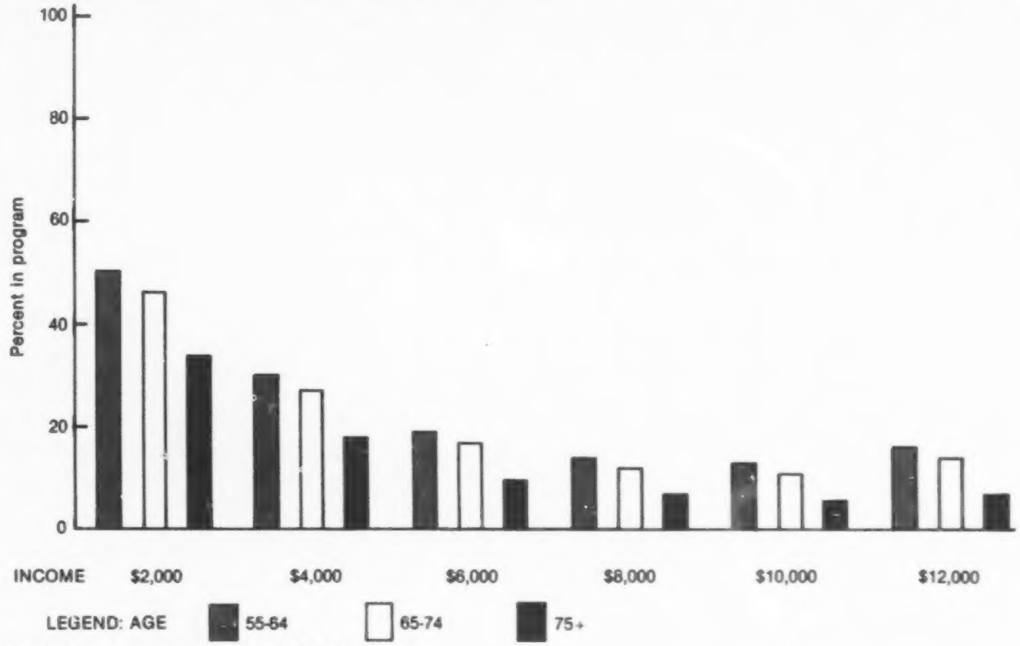
Owning a home, which negatively affected participation, did so more strongly among urban than rural residents in both surveys (figs. C-10 to C-13). Receiving Supplemental Security Income dramatically increased participation for all age groups (2,5). Participation of urban elderly increased more than that of rural elderly in the later survey and most markedly at the lower income levels; the increase in the *proportion* of eligible rural elderly participating, however, was relatively greater (2).

Households headed by women were significantly more likely to participate both in the local demonstration (5) and nationally, in urban areas in 1977-78, and rural areas in 1979-80. People who lived in larger households were more likely to participate in the FSP. Living alone had a statistically significant effect only in rural areas in 1979-80. Unfortunately, this means that the socially isolated population, one of the FSP target groups, is not well represented among participants.

The local cashout demonstration also found that people with some high school education were less likely to use food stamps. Other factors inhibiting participation included lack of awareness, stigma, and distance from FSP offices (5). Participation in the FSP was shown to increase food expenditures among those surveyed.

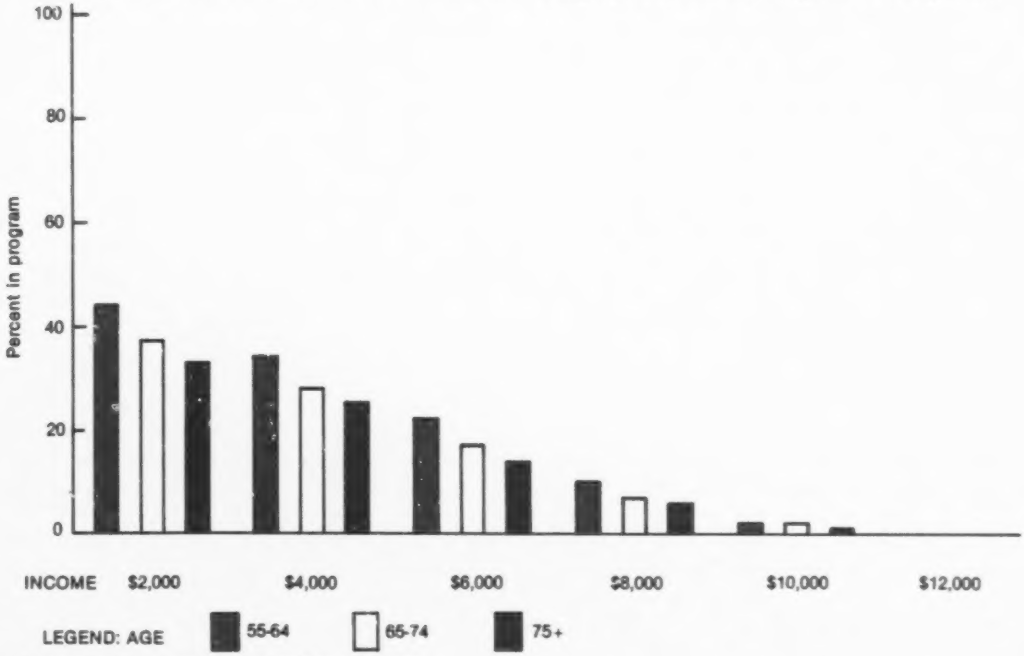
The cashout demonstration further evaluated the effects of the food stamps and cashout on dietary intake of nutrients. While the overall estimated effect of the program was positive for intake of all nutrients

Figure C-6.—1977-78 Low-Income NFCS Urban Sample, Food Stamp Program Participation



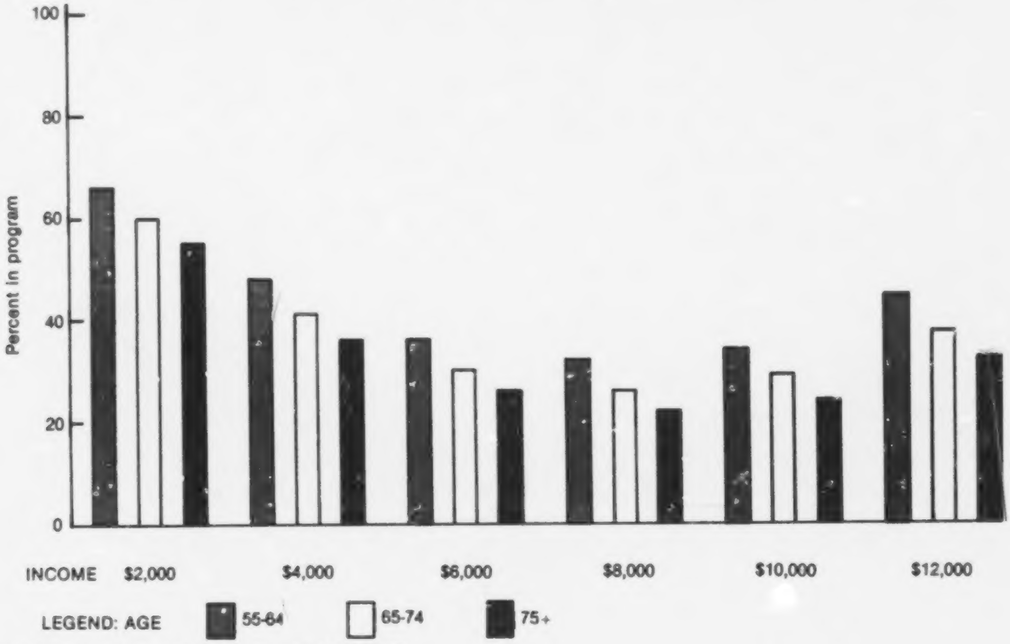
SOURCE: Akin, Guilkey, and Popkin (unpublished data), (2).

Figure C-7.—1977-78 Low-Income NFCS Rural Sample, Food Stamp Program Participation



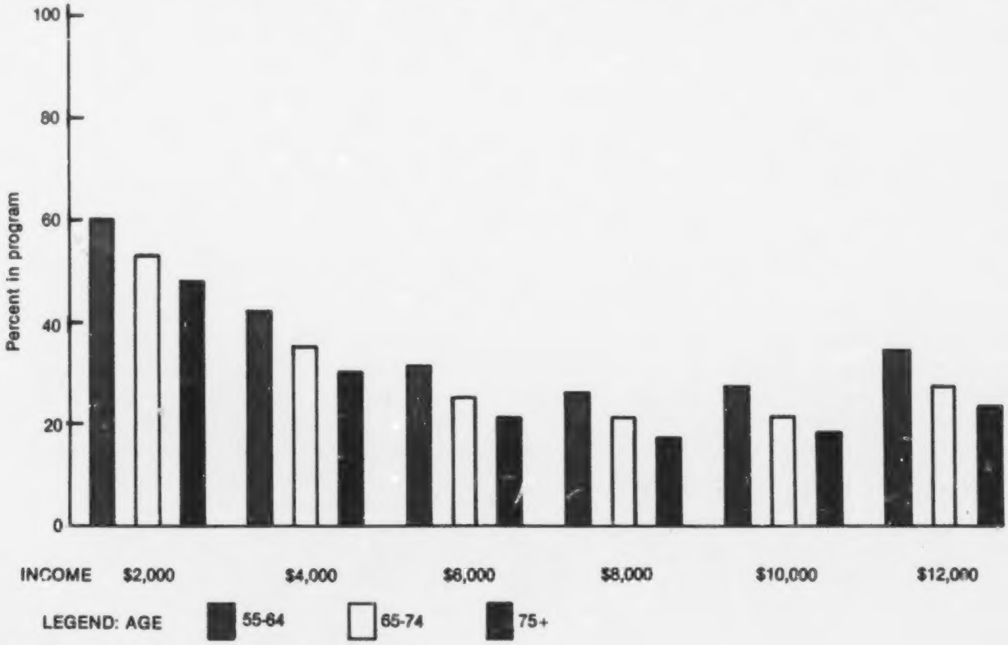
SOURCE: Akin, Guilkey, and Popkin (unpublished data), (2).

Figure C-8.—1979-80 Low-Income Followup Urban Sample, Food Stamp Program Participation



SOURCE: Akin, Gulikey, and Popkin (unpublished data), (2).

Figure C-9.—1979-80 Low-Income Followup Rural Sample, Food Stamp Program Participation



SOURCE: Akin, Gulikey, and Popkin (unpublished data), (2).

Table C-15.—1977-78 Low-Income Population: Participation in Elderly Food and Feeding Programs, Participation Status for Persons Aged 65 and Older (in percent)

Income as a percentage of poverty	In neither program	In only food stamp program	In only elderly feeding program[a]	In both programs	Total
< 100%	66.7%	29.5%	3.0%	0.8%	100%
≥ 100% and < 125%	58.7	36.0	3.4	1.9	100
≥ 125% and < 175%	75.0	20.9	2.6	1.4	100
≥ 175%	73.1	24.9	1.6	0.4	100
Race:					
White	68.8	26.8	2.9	1.5	100
Non-white	60.8	34.7	3.0	1.5	100
Residence:					
Urban	61.7	33.2	3.1	2.0	100
Rural	68.7	27.5	2.8	1.0	100

Note: Sample size is 2,501 households.

[a] Includes congregate feeding, meals on wheels, and other home-delivery programs. Because eligibility criteria for these programs exclude most of the 55 to 64 age group, statistics are presented only for those aged 65 and older.

SOURCE: Akin, Guilkey, and Popkin (unpublished data), (2).

Table C-16.—1979-80 Low-Income Population: Participation in Elderly Food and Feeding Programs, Participation Status for Persons Aged 65 and Older (in percent)

Income as a percentage of poverty	In neither program	In only food stamp program	In only elderly feeding program[a]	In both programs	Total
< 100%	41.0%	51.8%	1.2%	6.0%	100%
≥ 100% and < 125%	41.7	52.0	2.8	3.5	100
≥ 125% and < 175%	56.3	41.9	1.4	0.4	100
≥ 175%	63.5	33.2	1.7	1.7	100
Race:					
White	53.2	42.8	2.4	1.7	100
Non-white	45.2	50.1	1.7	3.0	100
Residence:					
Urban	48.5	46.5	2.4	2.6	100
Rural	50.1	46.0	1.8	2.0	100

Note: Sample size is 1,588 households.

[a] Includes congregate feeding, meals on wheels, and other home-delivery programs. Because eligibility criteria for these programs exclude most of the 55 to 64 age group, statistics are presented only for those aged 65 and older.

SOURCE: Akin, Guilkey, and Popkin (unpublished data), (2).

surveyed, the improvement was significant only for calcium (5). There were no significant differences for the intake of nine nutrients between food stamp participants and nonparticipants. Those who received cash instead of stamps, however, had a higher intake of four out of the nine nutrients: protein, calcium, vitamin C, and thiamine.

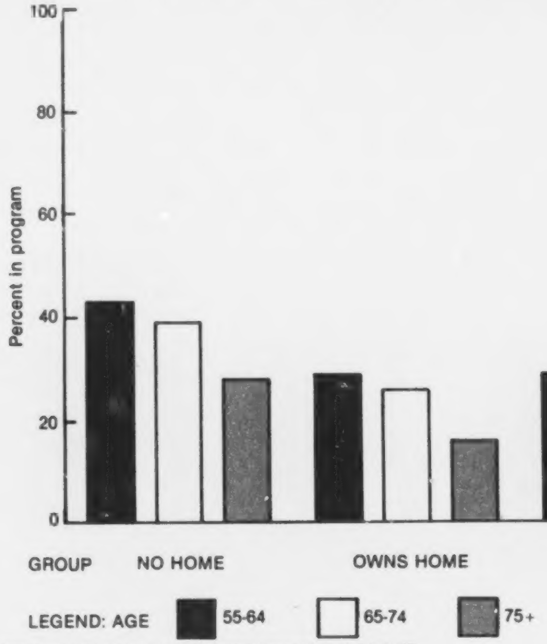
OTHER FOOD ASSISTANCE PROGRAMS

Food For Seniors, or the Elderly Feeding Pilot Project, was initiated by Congress in September of 1982 to analyze the cost effectiveness of distributing food commodity supplements to prevent chronic malnutrition among the elderly. The project was authorized to continue through fiscal year 1984 at three Commodity Supplemental Food Program sites (Public Law 97-98 and Public Law 97-103). These sites are located in Detroit, Des Moines, and New Orleans, with participation at each limited to 1,900 elderly persons.

The commodities are commercially produced for the U.S. Department of Agriculture through competitive bids and include milk, canned meats, vegetables, fruits, dried egg mix, peanut butter, instant potatoes, and cheese (11). The monthly supplements, worth more than $25 at retail, are meant to satisfy 100 percent of the requirements for protein and other key vitamins and minerals at a cost of about $11, which includes the food and local administration.

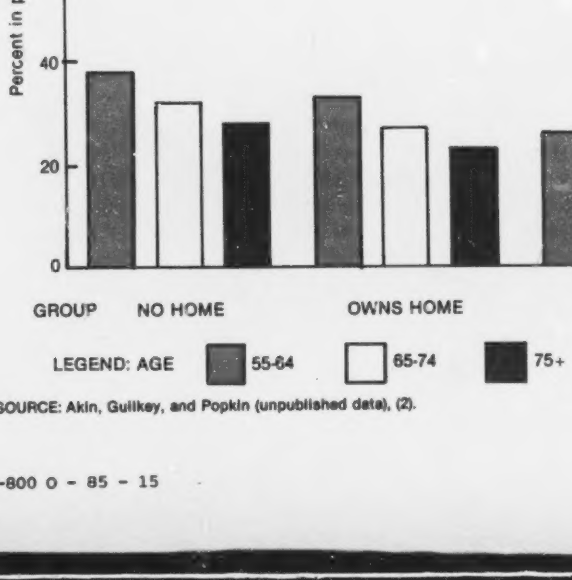
An initial progress report from the Detroit site reports that the supplement is satisfying more than 100 percent of the monthly RDA of protein, vitamin

Figure C-10.—1977-78 Low-Income NFCS Urban Sample, Food Stamp Program Participation, by Housing Ownership and Receipt of Supplemental Security Income (SSI)



SOURCE: Akin, Guilkey, and Popkin (unpublished data), (2).

Figure C-11.—1977-78 Low-Income NFCS Rural Sample, Food Stamp Program Participation, by Housing Ownership and Receipt of Supplemental Security Income (SSI)



SOURCE: Akin, Guilkey, and Popkin (unpublished data), (2).

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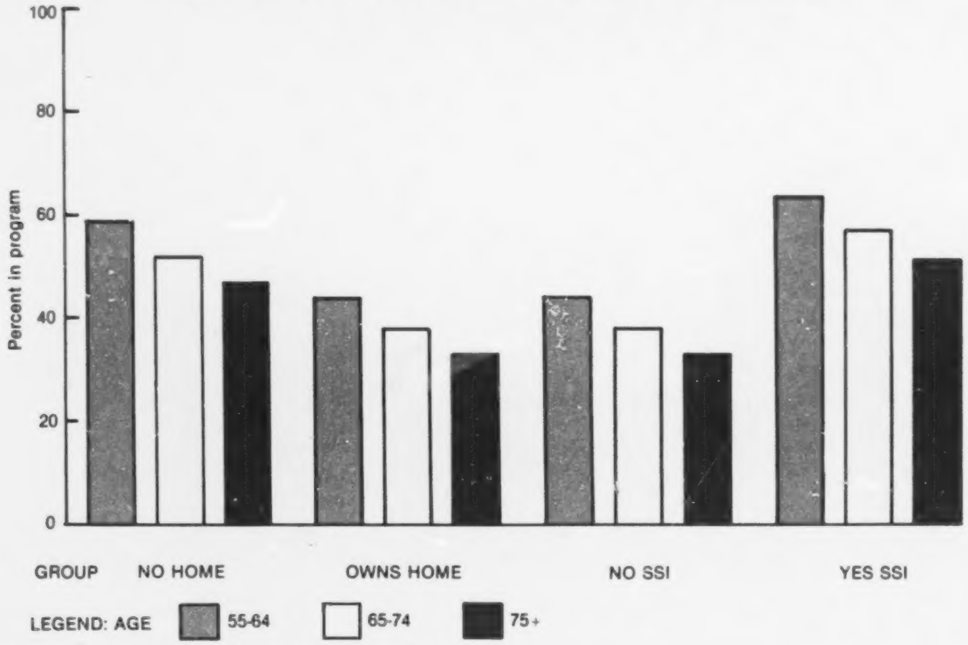
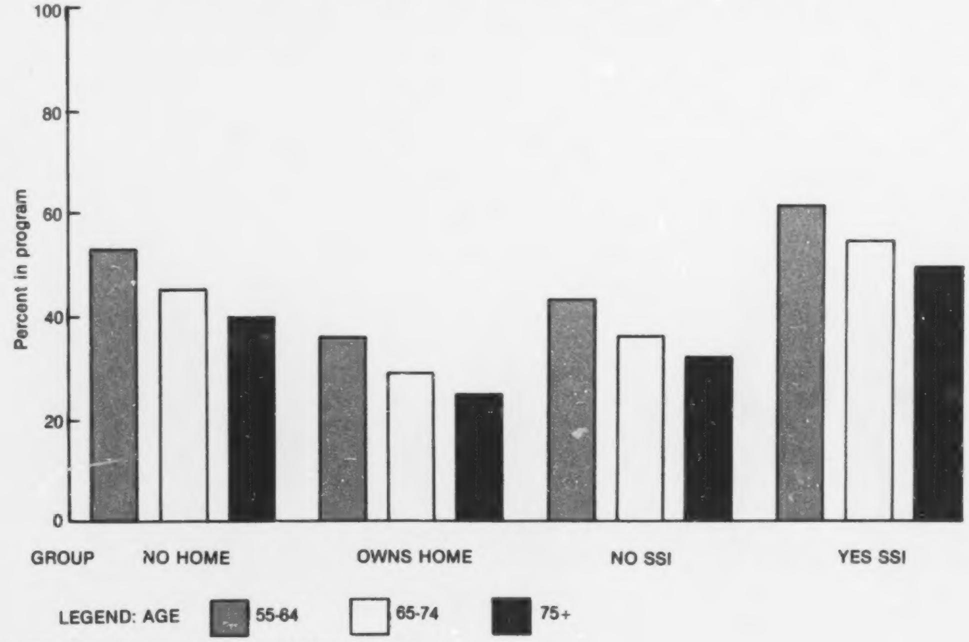
Figure C-12.—1979-80 Low-Income Followup Urban Sample, Food Stamp Program Participation, by Housing Ownership and Receipt of Supplemental Security Income (SSI)



SOURCE: Akin, Guilkey, and Popkin (unpublished data), (2).

Figure C-13.—1979-80 Low-Income Followup Rural Sample, Food Stamp Program Participation, by Housing Ownership and Receipt of Supplemental Security Income (SSI)



SOURCE: Akin, Guilkey, and Popkin (unpublished data), (2).

D, calcium, iron, riboflavin, vitamin B-12, and phosphorus. Of the participants surveyed (20 percent), all who responded said that the program had helped them and that they enjoyed the food. A majority of the participants were female, widowed, and black (11).

Conclusion

Overall, the title III congregate meal programs appear to be meeting many of the guidelines for nutrient intake. The evaluations, however, are flawed in both the gathering and the analysis of the data. Menus and meals have never been analyzed for some of the lesser known nutrients such as zinc, folic acid, and vitamin B_6. Recent surveys involving biochemical assessments of the nutrition of the elderly suggest that a significant proportion of this age group may be deficient in these nutrients (3,7,16,27,28,44).

The sanitary and esthetic quality of program meals, the program staff, and nutritional education for participants were all found lacking in some surveys, suggesting the need for more regulatory policy and further evaluations.

Finally, further study is needed to determine if either the meal programs or the rapidly growing Food Stamp Program are really reaching the most needy people. Analysis of the participant profile in both programs reveals that some of the target groups, especially the socially isolated, are not well represented among participants. This suggests that some needy groups are either ill-informed about the programs and nutrition in general or that the programs are not readily accessible to them.

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Appendix D

Biotechnology

Introduction

Recent advances in recombinant DNA (rDNA) technology, cell fusion technology (monoclonal antibodies), and bioprocessing technology (biological production) promise to make earlier diagnosis possible and improve disease prevention and treatment. The ability to develop more definitive diagnostic technologies and predictive tools, as well as more cost-effective therapeutics, gives biotechnology the potential to reduce the severity and burden of chronic disease among the elderly.

New methods of biotechnology may improve pharmaceutical development and production in a variety of ways, perhaps most importantly by increasing the supply, variety, and quality of products now being marketed by making them more effective, convenient, safe, or economical.

Monoclonal antibody and rDNA technologies can complement each other. For example, monoclonal antibodies (MAbs) can be used to identify and purify new compounds, and rDNA technology can be used to biologically produce them. Yet without advances in bioprocess technology, the production process by which genetically manipulated micro-organisms are adapted for large-scale industrial use, rDNA-based pharmaceutical development is not possible.

Cell fusion—monoclonal antibodies

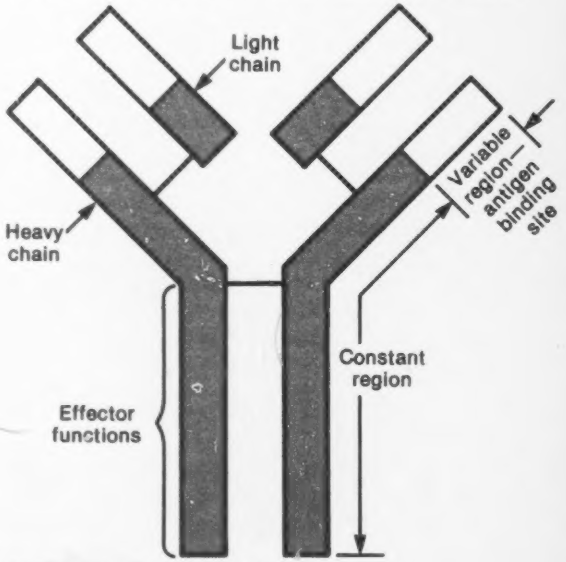
Cell fusion, the artificial joining of cells, combines the desirable characteristics of different types of cells into one cell. Through cell fusion, the traits for immortality and rapid proliferation (derived from certain cancer cells), and the traits for production of specific antibodies (derived from specialized cells of the immune system) are combined in the new cell line (hybridoma) that results from the fusion. These hybridomas produce large amounts of monoclonal antibodies—antibodies that are specific to only one kind of antigen. Because of their specificity and their ability to "home in" on specific kinds of cells, MAbs can be used for a variety of pharmaceutical applications, ranging from diagnostic assays, passive vaccines, and drug delivery (i.e., chemotherapy) to body imaging and purification.

HOW ANTIBODIES WORK

Production of antibodies is one aspect of a complex of biological reactions known as the immune response. Antibodies are produced by specialized cells (B lymphocyte cells) found in the spleen, lymph nodes, and blood. B-cells recognize substances foreign to the body (antigens) and respond by producing antibodies that specifically recognize and bind to the antigens. Antigens can be almost any substance recognized by the body as foreign—bacteria, viruses, or even chemicals. The binding of the antibody to the antigen results in breakdown of the antigen, thereby removing the antigenic response in the body.

Structurally, all antibodies have the same basic Y-shape—two "heavy" chains and two "light" chains (see fig. D-1). Each heavy and light chain has a "variable" and a "constant" region. The variable region contains the site that recognizes and binds to a specific antigen in much the same manner as a lock to a key. This site varies greatly from antibody to antibody, allowing for a wide range of antigens to be recognized by the large number of different antibodies that are naturally produced by the body. The constant region of the antibody is associated with effector functions, such as the secretion of antibodies from the B-cells, and "signaling" to the immune system after the antibody binds with the target antigen. Thus, if the antigen is a complex macromolecule (e.g., a protein) with many an-

Figure D-1.—Structure of an Antibody Molecule



SOURCE: Office of Technology Assessment.

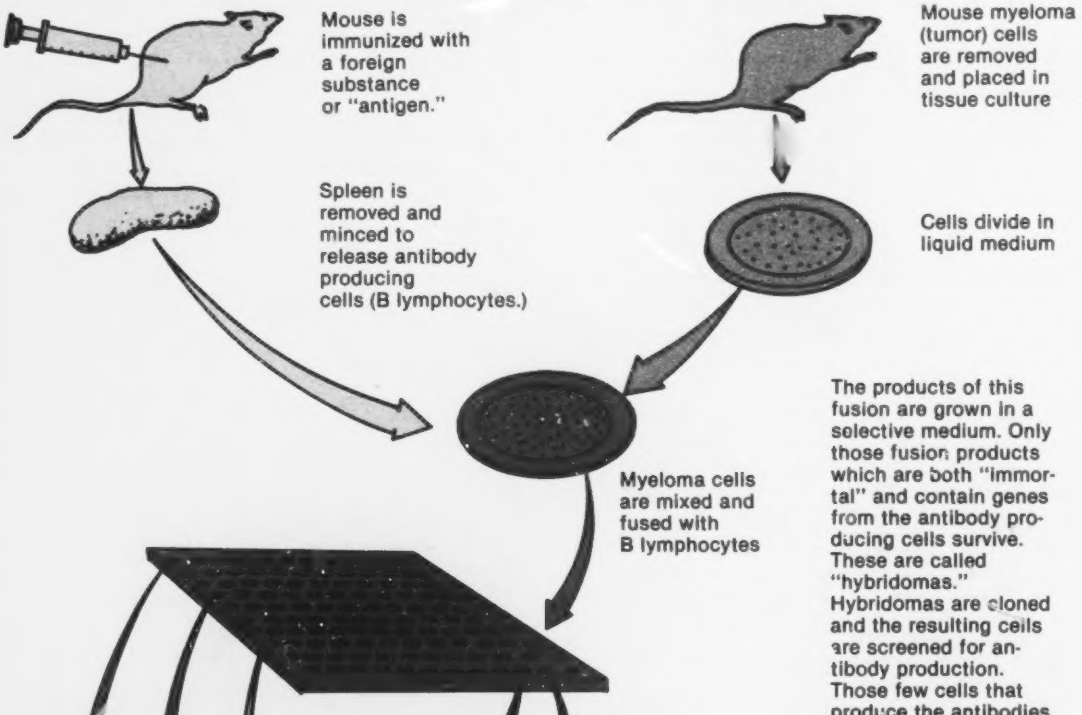
tigenic determinants, a large number of different B-cells, and a variety of antibodies specific to those determinants will be produced. By virtue of a very complex genetic scheme, millions of potential antibodies are possible, but each B-cell is committed to only one antibody. When the appropriate antibody-producing B-cell contacts and "recognizes" its antigen, it clones a set of identical cells, all of which produce the genetically programmed antibody for the life of the cells.

THE MAKING OF ANTIBODIES

Antibodies have long been important tools for clinicians and researchers who use an antibody's specificity to identify particular molecules or cells and to separate them from mixtures. The conventional production method by which antibodies are made for diagnostic, therapeutic, and investigational purposes is to inject an antigen into a laboratory animal and, after an immune response is triggered, to collect antiserum (blood serum containing antibodies) from the animal. This method of antibody production results in production of many antibodies of several classes and various specificities. Moreover, the limited life span of the animal prohibits large-scale production of reproducible antibodies.

Cell fusion technology and the hybridoma-producing MAbs that result allow for the production of an homogeneous and therefore reproducible reagent in almost unlimited quantities. Figure D-2 illustrates the method used to prepare MAbs. As in vitro diagnostic tools, murine MAbs (MAbs derived from mice) are very valuable, but as clinical tools for in vivo diagnosis and treatment of human disease, their use is limited by the fact that mouse protein is antigenic in humans and eventually would be rejected by the body as a foreign

Figure D-2.—Preparation of Monoclonal Antibodies



Mouse is immunized with a foreign substance or "antigen."

Mouse myeloma (tumor) cells are removed and placed in tissue culture

Spleen is removed and minced to release antibody producing cells (B lymphocytes.)

Cells divide in liquid medium

Myeloma cells are mixed and fused with B lymphocytes

The products of this fusion are grown in a selective medium. Only those fusion products which are both "immortal" and contain genes from the antibody producing cells survive. These are called "hybridomas." Hybridomas are cloned and the resulting cells are screened for antibody production. Those few cells that produce the antibodies being sought are grown in large quantities for production of monoclonal antibodies.

SOURCE: Office of Technology Assessment, adapted from Y. Baskin, "In Search of the Magic Bullet," *Technology Review*, October 1982, pp. 19-23.

substance. Thus, for in vivo application, MAbs must be produced from a human myeloma/human spleen cell fusion. Several investigators and many new biotechnology firms have reported development of human myelomas that are suitable for hybridoma preparation, and successful fusions apparently result from using these cell lines (17).

DIAGNOSIS AND DETECTION USING MAbs

The ability of MAbs to "zero in" or target very specific antigens could theoretically give rise to as many detection tests as there are antigens. Clinical trials for MAb-based diagnostics are under way in medical centers all around the country and the Food and Drug Administration (FDA) has already approved some 30 MAb-based diagnostic kits. Although the greatest potential diagnostic application of MAbs may be for cancer, MAbs are being used most successfully in diagnostic kits to test for viral and bacterial infection and other factors. MAbs are also expected to find expanded application in detecting, purifying, and/or measuring such things as enzymes, hormones, plasma proteins, drugs, and micro-organisms, leading to better prevention and treatment of chronic disease.

Viral and Bacterial Infections.—A major problem in clinical microbiology is the inability to rapidly identify the particular agent responsible for clinical disease. In many instances, infectious organisms require from 3 days to 3 weeks for culturing. As a result, physicians often prescribe a broad-spectrum drug rather than wait for laboratory data. MAb technology and probe technology (discussed later in this section) offer the potential for rapid and highly specific tests to replace current culture techniques for direct detection of infectious organisms.

Infectious diseases are a major cause of hospitalization in the United States, accounting for one-quarter of all hospital admissions (11). While hospitalized, patients with weakened or deteriorated immune function (e.g., elderly patients or patients undergoing chemotherapy) are often plagued by "opportunistic" infections that may jeopardize recuperation. Several days may pass before the infection can be diagnosed and treatment initiated. Many U.S. companies are developing MAb-based diagnostic products for both viral and bacterial infections—including two major pathogens, *Klebsiella* and *Pseudomonas*. These very accurate diagnostics can be read rapidly (often within hours).

Use of MAbs in virology has made it possible to identify new substrains of many viruses and to make distinctions between isolates from different parts of the world (11). The ability to identify and differentiate among the substrains is expected to help in the preparation of more effective influenza vaccines. Vaccines against such viruses will be especially useful among the elderly population, in whom influenza can be fatal.

Cancer.—Cancer cells have characteristic proteins called tumor-associated antigens as cell surface markers or as internal cellular markers that may be shed into the blood or other body fluids. Although no antigen that occurs exclusively in cancer cells has been identified, tumor-associated antigens that are relatively restricted to cancer cells, or to certain kinds of cancers (as opposed to normal cells), have been identified. Additionally, certain types of malignancies, such as B-cell tumors, possess quite distinctive markers which allow useful characterization. At this time MAbs have been generated to recognize antigens associated with almost all human malignancies and have been made and used in clinical trials for a number of different cancers. MAbs are also being made against carcinoembryonic antigen, a proposed marker for colon cancer, as well as antigens such as alpha-fetoprotein, a protein that can be used to diagnose early stages of liver cancer (14). Two MAb-based diagnostic kits have already been approved by the FDA for carcinoembryonic antigen, as have other kits for prostatic acid prosphatase and human chorionic gonadotropin, hormones used as indicators for prostatic or testicular cancer. In other cases, MAb reagents are being used to identify tumor cells by staining tissue specimens.

The currently available range of human MAbs is likely to be greatly extended in the next few years as more and more labs make use of hybridoma techniques. New MAbs are likely to prove useful in diagnosis and subtyping of carcinomas, sarcomas, and other related neoplasms (16). Moreover, a greater number of MAbs will be available to monitor the level of antigens in the body, thereby determining the effectiveness of treatment and extent of diseases.

Radioimmunoimaging.—The process of locating tumors in the body, large or small, early or late, can be facilitated by injecting radiolabeled MAbs specific to tumor markers into the body. The MAbs can then be read with ordinary imaging equipment and the location of the tumor identified. Radiolabeled MAbs can also be used to track metastasis of cancers. One of the attractions of radioimmunoimaging is that it has the potential not only to provide information about the size and location(s) of tumors, but to determine whether the cancer has metastasized. For example, MAbs can be developed that distinguish malignant from normal cells in the peripheral blood and bone marrow of patients with acute lymphocytic leukemia (15).

Imaging can also help physicians to determine which type of therapy may be appropriate. For example, knowing where the MAb has distributed throughout the body will tell the clinician whether it would be appropriate to attach a therapeutic agent to that same antibody. If there is sufficient localization, and if the antibody is not localizing at some other crucial tissue that would be irreparably damaged by the therapy, immunotherapy might be the treatment of choice.

In addition to their application in locating tumors, radiolabeled MAbs specific to fibrinogen are also being developed to locate and characterize blood clots.

Heart Attack.—Myocardial infarction, a blood clot-generated heart attack, causes death of heart tissue cells. When heart tissue dies, cardiac myosin (contractile muscle fiber) is released into the bloodstream. MAb diagnostics, based on MAb affinity for myosin, are being developed to signal the beginning of myocardial infarction (13) and to assess the extent of permanent myocardial damage shortly after a heart attack occurs (5). A radiolabeled MAb could be used to identify the damaged part of the heart muscle and to quantify the percentage of muscle damaged. Such a test would enable doctors to decide whether a patient is still at risk from infarction and to prescribe appropriate treatment much earlier.

Brain Disorders.—The main biochemical abnormalities that occur in aging and in dementing disorders, especially senile dementia, appear to involve defects in neurotransmitter synthesis. MAbs have recently been used to isolate specific proteins that are present only on a small subset of neurons in the brain. MAbs can thus be used to detect and quantify minute amounts of neurotransmitters present in different regions of the brain. They are expected to gain increased use in isolating many of the small peptides that appear to function as neurotransmitters. The ability to quantify the level of these neurotransmitters would be useful in studying normal functioning under different circumstances and in examining the transmitter imbalances associated with a variety of neurological disorders like dementia of the Alzheimer type. Detection of distinctive abnormal cellular components, such as the "paired helical filaments" of Alzheimer disease, may also provide earlier and more certain diagnosis.[1]

Development of MAbs promises to make the identification and tracing of cell components more precise. Using MAbs, scientists can locate and study cells and cell types in the nervous system that share a common function by identifying particular molecules in the midst of complex nerve tissue. Transmitter receptor makeup is being investigated by this technique with potential benefits for diagnosing or treating diseases. It is expected that MAbs will soon help answer fundamental questions about neurobiology, such as how nerve terminals recognize and interact with correct target cells, perhaps resulting in a wider understanding of brain disorders.

PURIFICATION

Because of their unique properties of homogeneity, specificity, and affinity, MAbs can be used effectively to purify molecules, especially proteins. Various important proteins, including leukocyte interferon, are already being purified using MAbs (17). Many others, including a number of protein "growth factors," have been isolated and are being characterized, with the possibility that they may soon be candidates for production by rDNA technology. Furthermore, large-scale production of very pure active vaccines, using MAbs to bind and isolate the antigens, is now possible.

PREVENTION AND TREATMENT USING MAbs

Applications of MAbs to prevent or treat diseases are being pursued on two fronts: 1) administration of MAbs as passive vaccines to protect against specific diseases; and 2) coupling cytotoxic agents (e.g., diptheria toxin, ricin—a plant-derived toxin—or cobra venom) to MAbs that direct the agents to diseased cells (i.e., for drug delivery) (3).

Vaccines.—The technology being used to develop MAbs for diagnosing bacterial and viral infections is also being used to develop MAbs for passive vaccines and treatment of these infections. Very few viruses can be treated with drugs. Because viruses are parasites that live and reproduce inside human cells, it is nearly impossible to develop a drug that can search out and selectively kill the virus without harming the patient.

All viral infections and some bacterial infections are resistant to antibiotics. Worldwide medical research is focused on finding ways to manufacture MAbs for hundreds of known viruses. Human MAbs are currently being developed for the treatment of problematic bacterial infections that are often resistant to conventional antibiotics and commonly occur in hospitalized patients with long-term illnesses (e.g., *E. coli, Klebsiella,* and staphylococcus).

Immunotoxins.—With the advent of MAbs, the promise of a "magic bullet" approach to cancer therapy has been revived. In this case, the magic bullet is a tumor-specific antibody to which a toxic substance (immunotoxin) has been chemically linked (2). MAbs produced against unique antigens on the surface of, for example, leukemia cells can be linked to plant or bacterial toxins. Such immunotoxins may then be used for the selective and specific elimination of cells bearing the target antigen on their surface (9). Unlike conventional forms of cancer treatment, which kill both healthy and cancerous cells and often create serious side effects, it may be possible to design MAbs tagged with a chemotherapeutic agent that will bind only to proteins on the surface of cancer cells. Several research groups have reported success in using antibody-directed cytotoxic agents (14), marking the first time that tumor cells have been targeted for treatment while leaving normal cells unaffected.[2] The success of these experiments gives credence to the belief that antibody-drug, antibody-hormone, antibody-enzyme, or antibody-toxin conjugates may prove therapeutically useful in a variety of disease conditions.

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[1] See ch. 3 for a discussion of the aging brain and dementia.

Plasmapheresis.—The specific binding properties of MAbs give rise to potential applications in treating some of the autoimmune diseases—conditions in which the body mistakenly identifies some of its own substances as foreign and manufactures antibodies against them. In myasthenia gravis, for example, antibodies are generated against the acetylcholine receptors in the neuromuscular junction, resulting in progressive weakening of the skeletal muscles. In a process akin to kidney dialysis, MAbs could potentially be used to purify the blood and remove these antibodies, thus improving the condition of the patient. Similarly, MAbs may prove useful in extracting factors implicated in arthritis.

Recombinant DNA

DNA (deoxyribonucleic acid), a universal genetic code, carries all of the information necessary to direct each and every function of every living organism; it contains the complete plan for life itself. **Recombinant DNA,** which includes gene cloning (reproduction), is a technique used to join DNA from different organisms for a specified purpose (e.g., production of a protein). It allows direct manipulation and alteration of the information coded in the genes so that the productive capabilities of the cell can be directed. **Genes,** composed of different arrangements of DNA, contain the information necessary for the creation and production of specific cellular proteins—compounds that perform most of the necessary functions of the cell. **Gene expression** is the mechanism whereby the genetic information of a cell is decoded and processed in order to manufacture a product, usually a protein.[3]

Through rDNA, genes from a human cell that are responsible for the production of a desired protein can be inserted in a micro-organism where the protein is expressed (i.e., produced) in large quantities as the micro-organism reproduces (see table D-1). The ability to develop micro-organisms that produce either new pharmaceuticals (e.g., vaccines against cancer) or large quantities of otherwise scarce pharmaceutical compounds (e.g., hormones that regulate immune response or calcium deposition) could revolutionize existing health care. Finally, the availability of pure substances (e.g., proteins) may enable researchers to answer more questions concerning cell biology and medicine.

DIAGNOSIS AND PREVENTION USING rDNA

DNA Probes.—Probes are powerful tools that can be used to recognize and bind to the inherent property of any cell—its DNA. The genetic information encoded by the DNA of each species is unique and, as such, can be used to identify that species. DNA is a double-stranded, helical molecule composed in part of four nucleotide bases—adenine (A), cytosine (C), guanine (G), and thymine (T) (see fig. D-3). When these bases pair up to form the rung-like structures of the DNA molecule, they do it exactly the same way every time—A always pairs with T and C always pairs with G. The pairing is accurate, but not very strong. Thus, when the DNA "unzips," leaving a series of unpaired bases on each strand, a strand with the corresponding sequence of nucleotide bases must be found before another double helix can be formed.

DNA probe technology is based on the fact that DNA is composed of two parallel, complementary strands which are uniquely matched and held together by chemical bonds. If separated, the two complementary strands can find each other and rejoin (known as hybridization), even in the presence of a large number of noncomplementary molecules.

To make a probe, a specific segment of DNA is removed from a biological sample, or a segment of DNA is synthesized to match a segment of DNA thought to exist in the patient. This piece of DNA is then labeled with a substance that allows researchers or clinicians to follow it as it searches for a complementary strand of DNA that has been obtained from the patient and treated so that the double-stranded DNA is separated. If the probe "pairs up" with the complementary strand

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[2] An investigator at Scripps Clinic recently succeeded in linking cobra-venom factor (CVF) which is itself nontoxic, but is found in cobra venom, to MAbs directed against a specific surface antigen found on a human melanoma cell line. These CVF-conjugated MAbs were subsequently able to specifically kill the melanoma cells. In clinical trials at Johns Hopkins University and Hospital, radioactive iodine has been tagged to MAbs specific to liver tumor cells. Many of the patients have experienced remissions and shrunken tumors; one has been in remission for 3½ years (8).

[3] Different proteins perform different functions. Many are expected to be useful in the prevention and treatment of chronic conditions among the elderly. Enzymes, for example, are proteins that catalyze biological reactions. Examples include thrombolytic and fibrinolytic enzymes that dissolve blood clots. Hormones, some of which are also proteins, control regulatory functions (e.g., insulin is a protein hormone that regulates sugar metabolism and other functions; and interferon, an immune regulator, regulates the response of cells to viral infections). Other proteins have other specialized functions (growth factors, for example, regulate the growth of a variety of different body cells such as nerves and bones).

Table D-1.—Some Proteins With Possible Pharmaceutical Applications Being Developed With Recombinant DNA Technology

Class/substance	Size (number of amino acids)	Function	R&D status	Project sponsors	Applications
Human growth regulators:					
Growth hormone (GH)	191-198	Promotes growth	Cloned, expressed, 1979	Genentech (U.S.)/ Kabigen AB (Sweden) UCSF/Eli Lilly (U.S.)	Growth promotion; healing burns, fractures; cachexia
Somatostatin	14	Inhibits GH secretion	Cloned, expressed, 1977	UCSF/Genentech	Adjunct to insulin
Somotomedins	44-59	Mediates action of GH	Cloned, expressed, 1982	Chiron (U.S.)	Growth promotion, regulation
Growth hormone releasing factor (GRF)	44	Increases pituitary GH release	Isolated, sequenced, synthesized, 1982	Salk Institute (U.S.)	Growth promotion
Calcium regulators:					
Calmodulin	148	Mediated calcium's effects	Determined to be unprofitable[a]	None	Numerous applications in basic research; hypertension
Calcitonin	32	Inhibits bone resorption	rDNA production	Genentech, Amgen (U.S.)	Bone disease therapy
Parathyroid hormone (PTH)	84	Mobilizes calcium; prevents calcitonin excretion	Cloned, but no production	Massachusetts General Hospital	Osteoporosis therapy; calcium metabolism
Reproductive hormones:					
Luteinizing hormone (LH)	Beta chain; 115[b]	Females: induces ovulation Males: stimulates androgen secretion	Cloning in progress (glycoprotein)	Integrated Genetics (U.S.)/Serono Labs (Italy)	Antifertility
Follicle-stimulating hormone (FSH)	Beta chain; 115	Induces ovarian growth	Cloning in progress (glycoprotein)	Integrated Genetics/ Serono Labs	Reproductive services
Human chorionic gonadotrophin (HCG)	Beta chain; 147	Like LH; more potent	Cloning in progress (glycoprotein)	Integrated Genetics/ Serono Labs	Pregnancy testing
Relaxin	52	Dilation of birth canal; relaxation of uterus	Cloning in progress (non-glycoprotein)	Genentech	Soften bone connective tissue of reproductive tract; antiarthritic (?)
Neuroactive peptides:					
β-Endorphin	31	Analgesia	Cloned, expressed	Amgen, others	Analgesia
Enkephalins	5	Analgesia	Cloning in progress	Amgen, others	Analgesia
Pancreatic endorphin	N.A.[c]	Undetermined	Cloning in progress	Endorphin, Inc.	Analgesia, particularly in childbirth
Lymphokines and immunoactive peptides (other than interferons):					
Interleukin-2	133	Promotes T-cell growth, activity	Cloned, expressed	Ajinomoto Co. (Japan) Japanese Cancer Institute Immunex (U.S.) Cetus (U.S.) Chiron Genex (U.S.) Biogen (U.S.) Genetics Institute (U.S.) Interferon Sciences (U.S.) Quidel (U.S.)	Maintain T-cell cultures; immunotherapy
Thymosin (fraction 5)	10-150	Promotes maturation of bone marrow cells, T-cell differentiation	Purified, sequenced	George Washington University	Immunodeficiency diseases
Thymosin (alpha 1)	28	Promotes T-helper and T-amplifier functions	Purified, sequenced cloned, 1979	Hoffmann-La Roche (Switz.) Genentech	Systemic lupus erythmatosis; other immune disorders
Thymic hormone factor (THF)	9	Promotes T-helper and T-amplifier functions	N.A.	N.A.	Antiviral protection in immunosuppressed patients
Thymic factor (TFX)	40	Restores delayed-type hypersensitivity	N.A.	N.A.	Cancer treatment
Thymopoietins	49	Inhibits B-cell differentiation	N.A.	Ortho Pharms. (U.S.)	Reversing immunodeficiencies

Table D-1.—Some Proteins With Possible Pharmaceutical Applications Being Developed With Recombinant DNA Technology—continued

Class/substance	Size (number of amino acids)	Function	R&D status	Project sponsors	Applications
Macrophage inhibitory factor (MIF)	N.A.	Inhibits macrophage migration	Cell fusion	Denki Kagaku (Japan)	Immunotherapy
Respiratory system regulators:					
Alpha-1-antitrypsin	45,000 molecular weight	Prevents destruction of alveolar walls by elastase	rDNA in yeast	Zymos Corp. (U.S.)/ Cooper Laboratories (U.S.)	Emphysema treatment

[a] Armor Pharmaceutical Co., the source of salmon calcitonin in the United States, does not believe that rDNA technology offers significant advantages over chemical synthesis for the production of salmon calcitonin at the present time. A New Drug Application is pending for human calcitonin, but this product is 20 times less than salmon calcitonin for the same effects. Hence, the economics of human calcitonin production are less advantageous than those of salmon calcitonin production.

[b] Most reproductive hormones thus studied are glycoproteins consisting of two polypeptide chains. All share a common (89 amino acids long) alpha chain. Biological activity is manifested in the beta chain, and most cloning efforts focus on producing the biologically active component.

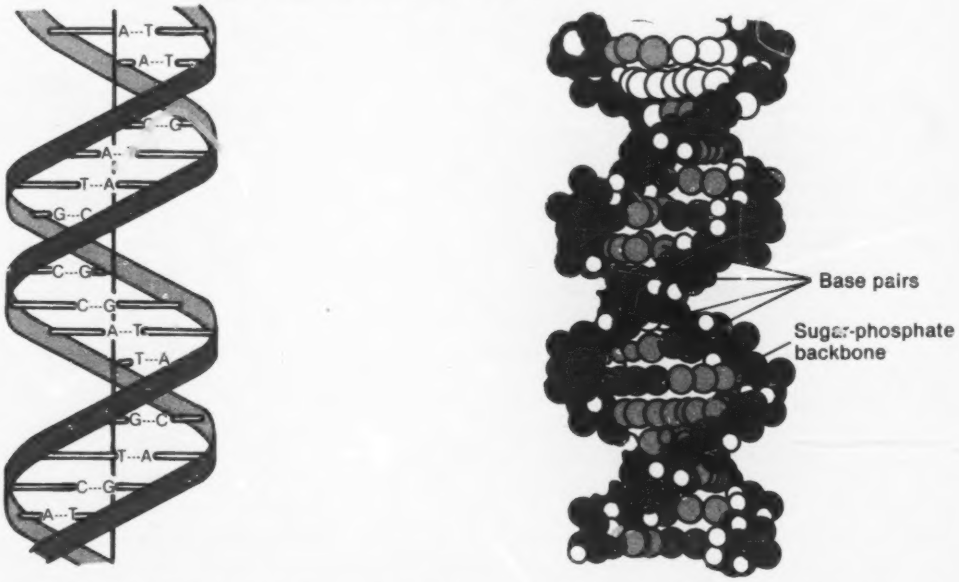
[c] N.A. = Information not available.

SOURCE: Office of Technology Assessment.

of DNA from the patient (i.e., if it finds a sequence in the DNA that matches its own), the existence of the organism or gene is confirmed (see fig. D-4). Thus, based on the hybridization property, probes can provide new methods for not only diagnosing infectious diseases but also for predicting genetic disorders and isolating minute quantities of chemicals.

- **Viral and bacterial infections.** The greatest commercial use of probes appears to be in detecting, within hours or even minutes, viral and bacterial infections. For instance, a probe obtained from a pathogenic organism (e.g., cytomegalovirus (CMV)) can be used to identify the presence of that virus within human cells, thus allowing specific

Figure D-3.—The Structure of DNA



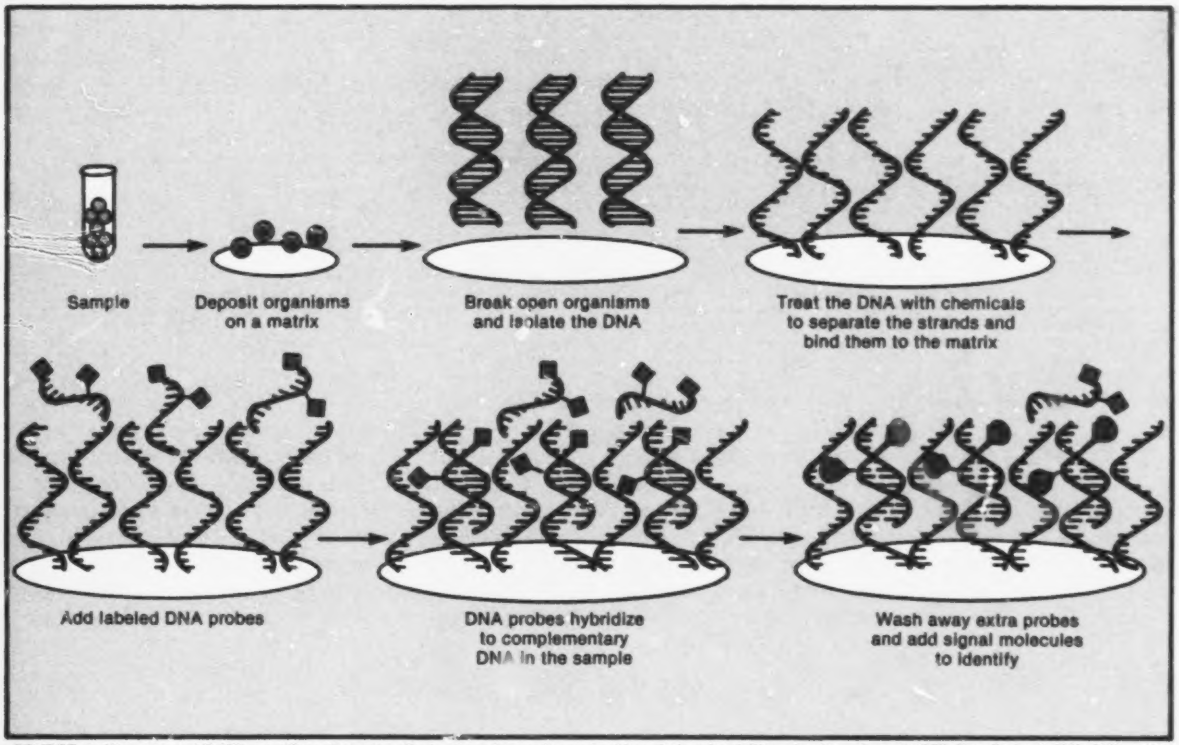
A schematic diagram of the DNA double helix.

A three-dimensional representation of the DNA double helix.

The DNA molecule is a double helix composed of two chains. The sugar-phosphate backbones twist around the outside, with the paired bases on the inside serving to hold the chains together.

SOURCE: Office of Technology Assessment.

Figure D-4.—DNA Probe Filter Assay


Sample
Deposit organisms on a matrix
Break open organisms and isolate the DNA
Treat the DNA with chemicals to separate the strands and bind them to the matrix
Add labeled DNA probes
DNA probes hybridize to complementary DNA in the sample
Wash away extra probes and add signal molecules to identify

SOURCE: A. Klausner and T. Wilson, "Gene Detection Technology Opens Doors for Many Industries," *Biotechnology*, August 1983; Ron Carboni, N.Y., N.Y., artist.

diagnosis based on whether or not the probe "pairs up" with the DNA in the cell. Currently, probes are being designed to detect a variety of viruses, including CMV, hepatitis B, rotavirus, and herpes.

- **Genetic disorders.** More than 3,000 human disorders result from defects in the basic genetic makeup of individuals (18). DNA probes are being designed to detect the genes that can cause some of the diseases. By screening individuals for genetic disorders (e.g., Huntington's disease), probes can serve as an early warning system for some diseases. If, in the future, more genes that are responsible for predisposing people to disease (e.g., cancer, mental disorders, heart attack) can be identified, doctors may use probes to identify those at risk. Harvard scientists have recently uncovered a rare inherited genetic defect that predisposes cholesterol buildup in tissues, which leads to heart attacks (7). The defective gene responsible for the disease was identified with a probe. In the future, scientists expect to identify genes that predispose individuals to common pathologies like cardiovascular disease, cancer, and mental disorders. Doctors could then use probes to identify persons who are at risk (4).
- **Characterization and isolation of proteins.** Aside from their use in screening for disposition to disease, probes are also being used to characterize and isolate many small peptides that act as neurotransmitters or regulators of the release of hormones from the pituitary gland. For example, probes are being used to unravel the mechanics of the brain's control of blood circulation and pressure.

The brain controls blood pressure in two ways: by controlling the release of peptides and hormones that adjust blood circulation in response to emotion and behavior, and by controlling the nerve cells that innervate the blood vessels and the heart. By using DNA probes, researchers are attempting to trace the networks and the dynamics of the interacting transmitters and peptide hormones involved in the brain's control of circulation with the hope of one day being able to control blood pressure. Probes might also ultimately be used to indicate changes in cellular DNA that accompany aging.

- **Cancer.** Recent discoveries indicating that some human tumor cells have identifiable oncogenes have spurred research and development efforts in this area (4). Earlier this year, the National Cancer Institute announced a 3-year, $1.8 million grants program to develop genetic techniques for cancer diagnosis, including DNA probes for oncogenes.

Vaccines.—At present, most vaccines are made from the organisms that cause the particular disease they are intended to prevent. These organisms (pathogens) are killed or otherwise treated ("attenuated") to make them nonvirulent. They are then injected as a vaccine. The body responds to the injection by producing antibodies against antigens on the surface of the attenuated organism. These antibodies then circulate in the system, protecting the body from an invasion by a live organism of the same kind. Thus, the immunity is conferred.

Limitations associated with current vaccines include: contracting the disease from incompletely attenuated viruses, incomplete immunization due to changes in the strains of the pathogen, and inefficient immune response to nonliving organisms.

Recombinant DNA is being applied to the production of vaccines that do not use the genetic material responsible for the pathogen's virulence. Instead, the gene for a surface protein of the pathogen is isolated and cloned, and the surface protein is used as the vaccine. Instead of the whole organism, only the surface protein responsible for eliciting the antibody response is used. This permits greater quantities of purer antigens to be used.

Among the elderly, influenza can often lead to death due to respiratory complications. Viral vaccines are being developed through rDNA for influenza types A and B. More effective vaccines such as these could prevent or minimize the effects of viral infections among the elderly.

Several research institutes have begun animal trials to test the efficacy of new vaccines targeted against melanoma and other cancers of the lung, breast, colon, and rectum. The vaccine, a short segment of DNA specific to the hormone human chorionic gonadotropin (hCG), is designed to simulate patients' immune systems to attack the hormone, which plays a role in tumor development. Many tumors, but not all, produce hCG. For instance, about 86 percent of all lung cancers produce hCG, and 50 to 60 percent of all breast cancers produce hCG, which not only helps ensure the survival of the tumor by fending off the body's immune system, but also works as a growth hormone to spur its development. Thus, if a vaccine could be delivered so that the immune system would fight hCG, further development of the tumor might be halted. More practically, the vaccine could be delivered after the tumor is removed to ensure complete eradication of the tumor cells.

TREATMENT USING rDNA

Therapeutic proteins normally present in human blood (e.g., clotting factors, antibodies, enzymes, certain hormones) are available only in limited supply; the only possible sources are animal or human blood, tissues, or urine. Recombinant DNA promises to provide an alternative route to the production of proteins for therapeutic purposes.

Thrombosis.—Thrombosis, the blockage of blood vessels by blood clots, is a major cause of disabling diseases and death (12). Blood clots, which are made of fibrin, platelets, a mixture of blood cells, red cells, and leukocytes, can cause heart attacks when lodged in the heart. When lodged in the brain, clots can cause strokes; in the lungs they can cause pulmonary embolisms.

Use of rDNA to make new and safer anticoagulants could reduce the incidence and severity of diseases induced by thrombosis by restoring blood flow to the affected heart muscle, thereby preventing or limiting permanent damage. Tissue plasminogen activator (TPA) and kidney plasminogen activator, for example, are two naturally occurring enzymes currently being produced via rDNA. They are being used to treat a wide variety of severe cardiovascular disorders, including heart attacks and arterial blockages. Both enzymes are specific for fibrin, the protein of which clots are made, and both are being developed for injection to dissolve potentially fatal blood clots. Two patients at Washington University in St. Louis, MO, and five at the University of Leuven in Belgium have received TPA treatment. When the TPA reached the heart, it caused dissolution of the clots that were causing the myocardial infarction. If TPA proves effective in further studies, it could be used in emergency rooms and ambulances to treat heart attack victims.

TPA has certain advantages over the two enzymes (urokinase and streptokinase) in current use. First, neither urokinase nor streptokinase are specific for blood clots (i.e., fibrin) (12). Both destroy other blood proteins. In order to avoid hemorrhaging, cardiac catheterization and coronary angiography are necessary to administer the enzymes directly to the site of the clot. Furthermore, streptokinase, because it does not occur naturally in humans, often elicits an allergic reaction that makes repeated treatments impractical.

Heart Attacks.—Renal renin, an enzyme produced by the kidneys, governs the release of angiotensin, which constricts blood vessels and raises blood pressure. Because the kidneys secrete only small amounts of renin that vanish quickly, the amount produced is insufficient to allow amino acid sequencing. With rDNA it should be possible to express human renin in host organisms and to accumulate enough for structural studies (6). Once renin's three-dimensional structure is determined, an analog can be developed that would bind to the renin receptor site, thereby inhibiting renin's effect. Renin analogs are being developed through rDNA with the hope that high blood pressure may soon be better controlled.

Emphysema.—Emphysema is caused in part by the gradual attack of lung tissue by natural enzymes (10). This lung deterioration can be accelerated by environmental factors such as air pollutants, bacteria, or cigarette smoke, or it can be caused by a congenital deficiency of alpha-1 antitrypsin (AAT)—a protein which counteracts degradative enzymes produced by the body to destroy foreign particles in the lungs. Without AAT, surplus enzymes attack lung tissue itself, causing emphysema. The availability of AAT could potentially be used to correct the condition in patients with the deficiency, as well as to prevent further deterioration in those with emphysema.

Neurologic Disorders.—Recent attention has focused on the variety of peptides found in the brain and other parts of the body that are assumed to function as neurotransmitters or neuromodulators. Included in this group are chemicals important in modifying pain, emotional response, and muscle tone; peptides implicated in seizure and postseizure events; and others active in controlling brain mechanisms of cardiovascular regulation and food intake. With the use of MAbs and DNA probes to isolate and characterize these peptides, coupled with rDNA to produce sufficient quantities for research (instead of purifying extracts made from large quantities of brain tissue), doctors may one day be in charge of a revolutionary arsenal of new compounds able to treat conditions (e.g., dementia) arising from neurologic disorders.

Cholecystokinin, for example, a peptide found in the gastrointestinal tract, was also recently found in the brain (1). Studies of genetically obese mice, which are obese because of excessive food intake, show the brains of these mice to contain three to four times less cholecystokinin than the brains of normal mice. Adding the peptide to the systems of the obese mice reduced their voracious eating. Information derived from such experiments may in the future serve to treat the problem of human obesity.

Immune Regulation and Modification (lymphokines and thymic hormones).—*Lymphokines,* such as interleukin-2 and interferon, are immune mediators and are produced by white blood cells (lymphocytes) when these cells are exposed to foreign bodies or alien cells. They regulate the response of the cells to microbial infections and cancer proliferation. Their presence (or absence) is thus crucial to the body's immune system.

The importance of lymphokines in preventing disease and understanding cellular function is fostering widespread research on these compounds. It is hoped that research efforts may lead to the use of lymphokines to stimulate the patient's own immune system to combat disease. For example, patients who are undergoing chemotherapy or radiation therapy may die from an unrelated infection such as pneumonia because their immune systems have been severely damaged. Interleukin-2, a lymphokine now being produced through rDNA, has been shown to restore immune balance in mice undergoing chemotherapy. The same results are now being sought for human applications.

Interferon, a class of immune regulators being produced through rDNA, is being considered for various pharmaceutical applications, including treatment for viral infections and cancer. In some clinical trials, interferon has inhibited tumor cell growth, although its effects on inhibiting tumor metastasis are better established than its ability to cause regression of primary tumors (17).

Thymic Hormones: The thymus appears to be an endocrine organ with the capacity to synthesize many different hormone-like products. These individual hormones probably act to regulate selective aspects of T-cell differentiation[4] (into killer, helper, and suppressor T-cells). The rationale for employing thymic hormones therapeutically in adults is based on the observation that circulating thymic hormone levels decrease dramatically with age as the thymus involutes, decreasing the efficiency of immune function. It has been suggested that the increased incidence of autoimmune diseases and cancers in the elderly population might reflect the loss of homeostatic control governed by the thymus (16).

Clinical trials using thymic peptides suggest that thymic hormones exert immunorestorative effects when administered to patients with T-cell immunity. Randomized trials in cancer patients have indicated that thymosin fraction 5 (which contains a number of active peptides) may be efficacious when administered as an adjunct to conventional chemotherapy or radiation therapy by reducing the immunosuppressive side effects of radiation and chemotherapy and helping the patient to mount a response to the disease. Other thymic factors (i.e., thymic humoral factor and thymic factor X) have shown promise in treating a variety of infectious diseases caused by adenoviruses. Potential therapeutic applications are also being investigated for autoimmune diseases. It is thought that some thymic hormones may help normalize the aberrant immunoregulatory cell activity that is characteristic of these diseases.

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[4] T-cells are lymphocytes produced by the thymus. Some T-cells recognize antigens and send messages to B-cells, which start making antibodies. Some T- cells assist B-cells in making antibodies; others suppress the same process; still others are themselves capable of seeking out antibody-bearing cells and killing them.

Conclusion

Many future pharmaceuticals, which cannot yet be identified, are likely to emerge during this decade from the basic work in biotechnology now under way. Their development would provide new therapies for many of the conditions that impair the functional ability of many of today's elderly. The advances arising from current basic research are expected to generate both new products and greater understanding of the aging process. This understanding should lead to significant reductions in the severity of chronic illness among the elderly and in the cost of health care for this growing segment of the U.S. population.

Appendix D references

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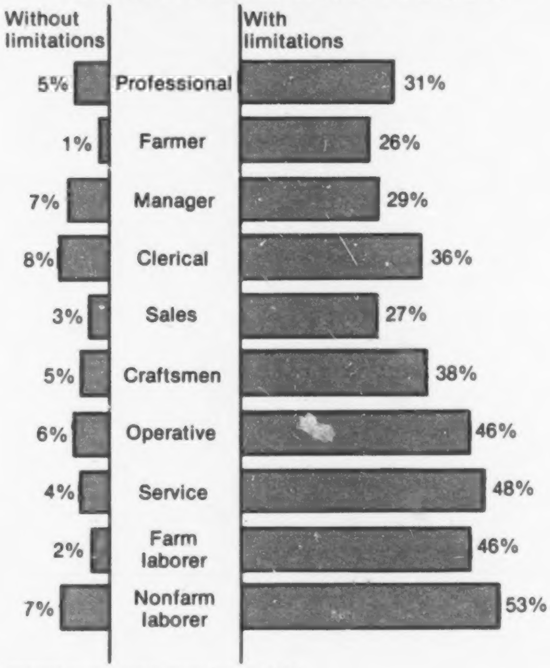
Appendix E

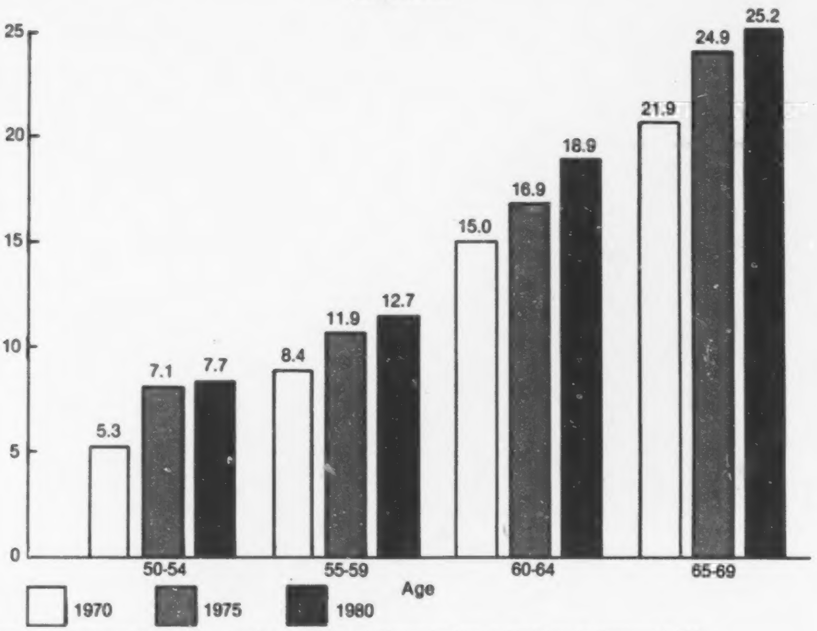
Workplace Technology and the Employment of Older Adults

Figure E-1.—Percent Men Aged 58 to 63 Not in the Labor Force, by Type of Longest Held Job and Presence or Absence of Work Limitations



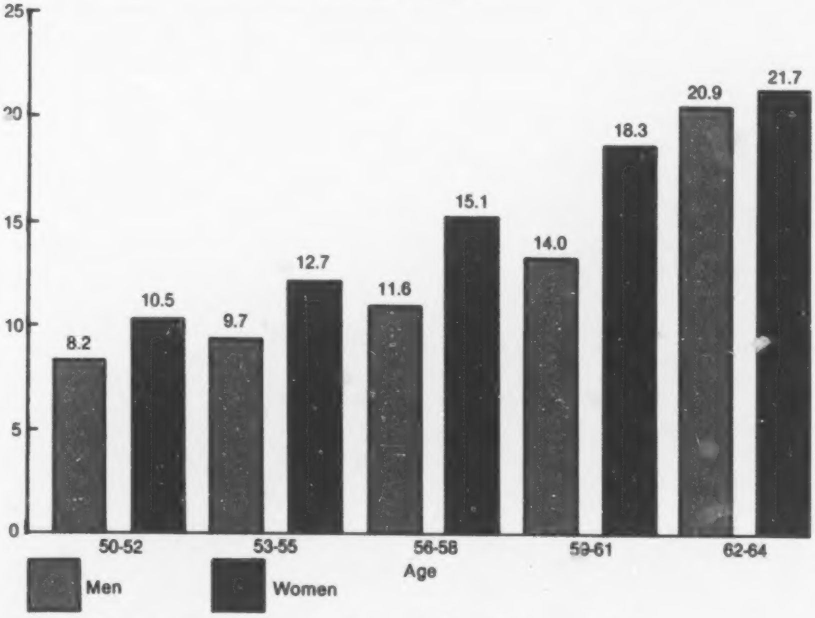
SOURCE: Retirement History Survey (1969).

Figure E-2.—Work Disability Rates for Men, by Selected Age Groups, 1970-80 (in percent)



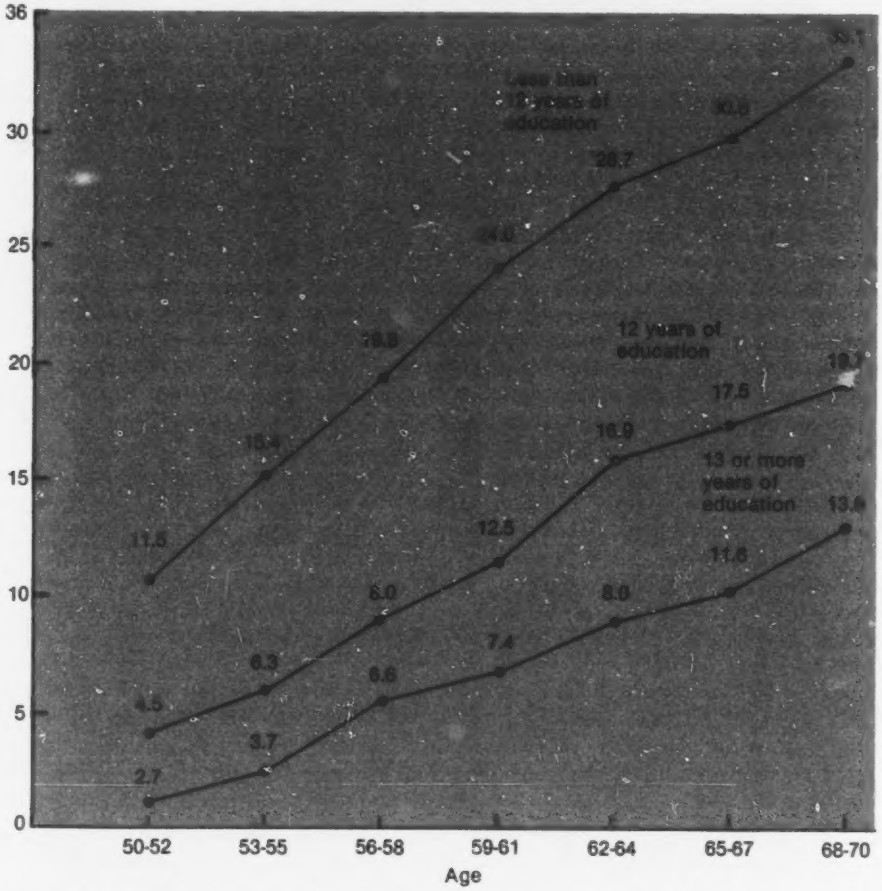
SOURCE: National Health Interview Survey, National Center for Health Statistics in Feldman (1983).

Figure E-3.—Work Disability Rates for Men and Women, by Selected Age Groups, 1976 (in percent)



SOURCE: 1976 Survey of Income and Education, Bureau of the Census in Feldman (1983).

Figure E-4.—Work Disability Rates for Men, by Selected Age Groups and Years of Education, 1976 (in percent)



SOURCE: National Health Interview Survey, National Center for Health Statistics. In Feldman, 1983.

Table E-1.—Labor Force Participation Rates and Number of Workers 45+ by Sex and Age, Selected Years, 1947-83

	Number (in millions)			LFPR[a] (in percent)	
Year	Total	Men	Women	Men	Women
Age 45-54:					
1947	10.6	7.9	2.7	95.5%	32.7%
1950	11.5	8.2	3.3	95.8	38.0
1960	14.9	9.6	5.3	95.8	49.8
1970	17.0	10.5	6.5	94.3	54.4
1980	16.9	9.9	7.0	91.2	59.9
1983	16.9	9.7	7.2	90.8	62.3
Age 55-64:					
1947	7.2	5.6	1.5	89.6	24.3
1950	7.6	5.8	1.8	86.9	27.0
1960	9.4	6.4	3.0	86.3	37.2
1970	11.3	7.1	4.2	83.0	43.0
1980	11.8	7.2	4.6	72.3	44.5
1983	12.1	7.2	4.9	69.7	42.1
Age 65+:					
1947	2.8	2.4	0.4	47.8	8.1
1950	3.0	2.5	0.6	45.8	9.7
1960	3.2	2.3	0.9	33.1	10.8
1970	3.2	2.2	1.1	26.8	9.7
1980	3.0	1.9	1.1	19.1	8.1
1983	3.0	1.8	1.2	16.5	7.9

[a] Labor Force Participation Rate.

SOURCES: *1980 Handbook of Labor Statistics*, Bureau of Labor Statistics; 1983 data from *Employment and Earnings*, Bureau of Labor Statistics, January 1984.

Table E-2.—Employment by Age, Selected Years, 1950-95 (numbers in millions)

	1950		1960		1970		1982		1995	
Age	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
16-44	41.7	65%	44.6	62%	54.3	63%	78.2	71%	92.4	70%
45-54	11.5	18	14.9	62	17.0	20	16.9	15	25.0	19
55-64	7.6	12	9.4	13	11.3	13	12.0	11	11.0	8
65+	3.0	5	3.2	4.5	4.5	3.7	3.0	2.7	3.1	2.3
Median age (years)	38.6		40.5		39.0		34.8		37.3	

SOURCE: Table 2, *Handbook of Labor Statistics 1980*, Bureau of Labor Statistics.

Table E-3.—Civilian Labor Force, by Sex, Age, and Race, 1955-83 (numbers in millions, LFPR in percent)

	1955		1970		1983	
	Number	LFPR[a]	Number	LFPR	Number	LFPR
Men:						
45-54	8.9	96.5%	10.4	94.3%	9.7	90.8%
55-64	6.6	87.9	7.1	83.0	7.2	69.7
65+	2.5	9.6	2.2	26.8	1.8	16.5
65-69	—	—	—	—	1.0	24.6
70+	—	—	—	—	0.8	11.8
White:						
45-54	8.0	96.7	9.5	94.9	8.6	91.5
55-64	5.7	88.4	6.5	76.5	6.5	70.8
65+	2.3	39.5	2.0	26.7	1.6	16.9
65-69	—	—	—	—	0.9	25.0
70+	—	—	—	—	0.7	12.0
Black and other races:						
45-54	0.8	94.2	9.3	88.2	0.8	84.5
55-64	0.5	83.1	6.1	79.2	0.5	58.6
65+	0.2	40.0	0.2	27.4	0.1	12.7
65-69	—	—	—	—	0.06	18.9
70+	—	—	—	—	0.05	9.2
Women:						
45-54	4.2	43.8	6.5	54.4	7.2	62.3
55-64	2.4	32.5	4.1	43.0	4.9	42.1
65+	0.8	10.6	1.1	9.7	1.2	7.9
65-69	—	—	—	—	0.7	15.0
70+	—	—	—	—	0.5	4.5
White:						
45-54	3.7	42.7	5.8	53.7	6.2	62.4
55-64	2.2	31.8	3.7	42.6	4.3	41.6
65+	0.7	10.5	1.0	9.5	1.1	7.9
65-69	—	—	—	—	0.7	15.1
70+	—	—	—	—	0.4	4.5
Black and other races:						
45-54	0.5	54.8	0.8	60.2	0.8	61.9
55-64	0.2	40.7	0.4	47.1	0.5	45.1
65+	0.06	12.2	0.1	12.2	0.1	7.5
65-69	—	—	—	—	0.06	14.3
70+	—	—	—	—	0.04	4.2

[a] Labor force participation rate.

SOURCE: *1980 Handbook of Labor Statistics*, Bureau of Labor Statistics; 1983 data from *Employment and Earnings*, Bureau of Labor Statistics, January 1984.

Table E-4.—Job Distribution by Industry, 1900-83 (numbers in millions)

Industry	1900		1920		1940		1960		1970		1983	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Mining	0.6	4%	1.2	4%	0.9	3%	0.7	1%	0.6	1%	1.0	1%
Construction	1.1	8	0.9	3	1.3	4	3.0	5	3.6	5	4.0	4
Manufacture	5.5	36	10.7	39	11.0	34	16.8	31	19.3	27	18.5	21
Transport	2.3	15	4.3	16	3.0	9	4.0	7	4.5	6	5.0	6
Trade	2.5	16	4.0	15	6.8	21	11.4	21	15.0	21	20.1	22
Finance	0.3	2	0.9	3	1.5	5	2.6	5	3.6	5	5.5	6
Services	1.7	11	3.1	11	3.7	11	7.4	14	11.5	16	19.7	22
Government	1.1	7	2.3	9	4.2	13	8.3	15	12.6	18	15.9	18
Total, non-farm employment	15.2		27.4		32.4		54.2		70.9		90.1	

SOURCES: From S. Stewman, 1900, 1920, 1940: Series D-127-141, *Historical Statistics of the United States, Colonial Times to 1970*, U.S. Bureau of the Census, 1975. 1960, 1970: Table No. 659 *Statistical Abstracts of the United States 1982-83*, U.S. Bureau of the Census, 1982. 1983: *Employment and Earnings*, U.S. Bureau of Labor Statistics, vol. 31(6), June 1984.

Table E-5.—Industry Distribution of Employed Men and Women Aged 45+, 1980 (percent)

	Men				Women			
Industry	45-54	55-59	60-64	65+	45-54	55-59	60-64	65+
Mining	1%	1%	1%	1%	0.3%	0.2%	—	—
Construction	10	9	8	6	1	1	1%	—
Manufacturing	29	29	28	12	19	18	17	9%
Durable	20	19	18	7	9	9	8	3
Non-durable	9	10	10	5	10	9	9	6
Transportation	10	10	8	4	3	3	3	1
Trade	15	15	16	21	20	19	21	26
Wholesale	5	5	5	5	2	2	2	2
Retail	10	10	11	16	18	17	19	24
Finance/insurance/real estate	5	5	5	7	8	7	6	6
Services	18	18	20	30	40	40	41	42
Public administration	8	7	6	5	5	6	4	3
Agriculture	4	5	7	14	1	1	2	2
Private household	—	—	—	—	3	4	5	11

SOURCE: National Policy Center on Employment and Retirement, University of Southern California, unpublished data from the 1980 *Current Population Survey.*

Table E-6.—Distribution of Workers Aged 55-64 and 65+, by Firm Size, 1979 (percent)

	Workers age 55-64					Workers age 65+				
Firm size (number of employees)	<25	25-99	100-499	500-999	1000+	<25	25-99	100-499	500-999	1000+
Mining	2%	—	13%	—	85%	—	—	—	—	—
Construction	43	23%	17	2%	15	47%	25%	15%	5%	7%
Manufacturing	7	13	13	4	63	31	32	24	6	6
Transportation/utilities	13	8	10	5	63	63	3	—	—	34
Wholesale trade	31	28	21	1	19	61	25	7	—	7
Retail trade	52	15	8	3	21	59	21	9	—	10
Finance/insurance/real estate	30	18	8	7	37	78	2	12	3	5
Services	30	13	17	10	29	51	18	11	4	15
Public administration	11	11	8	2	68	31	27	14	—	28

NOTE: The sample size on which the percentages are calculated is the population for which a firm size is identified; uncertain responses are not included.

SOURCE: National Policy Center on Employment and Retirement, University of Southern California, unpublished data from a special supplement to the May 1979 *Current Population Survey.*

Table E-7.—Unemployment by Reason for Unemployment, by Sex and Age, 1968-81 Averages (percent)

		Job losers				
Characteristics	Total	Total	On layoff	Other job losers	Job leavers	Reentrants
Men:						
25-54	3.7%	2.7%	0.9%	1.8%	0.4%	0.5%
55-64	3.0	2.3	0.7	1.5	0.2	0.5
65 and over	3.6	1.8	0.5	1.3	0.2	0.6
Women:						
25-54	5.5	2.4	0.9	1.5	0.8	2.1
55-64	3.4	2.0	0.8	1.3	0.4	0.9
65 and over	3.6	1.9	0.7	1.2	0.3	1.4

SOURCE: P. L. Rones, "The Labor Market Problems of Older Workers," *Monthly Labor Review*, May 1983.

Table E-8.—Median Weeks of Unemployment for all Persons With Unemployment Experience, Selected Years, by Sex and Selected Age Groups

Characteristic	1973	1975	1978	1981
Men:				
25-54	8.9	14.2	11.6	13.7
55-64	11.3	17.1	13.7	13.6
65 and over	14.9	19.1	18.3	16.2
Women:				
25-54	6.9	11.3	9.1	11.3
55-64	10.8	16.6	11.7	11.2
65 and over	8.6	19.1	14.3	13.3

SOURCE: P. L. Rones, "The Labor Market Problems of Older Workers," *Monthly Labor Review*, May 1983.

Table E-9.—Percentage Increase in Unemployment Rates for Job Seekers When Including Discouraged Workers, by Sex and Selected Age Groups (average of 1968-81)

Sex	Age 25 to 54	Age 55 to 64	Age 65+
Men	0.2%	0.5%	3.2%
Women	1.2	1.5	4.7

SOURCE: P. L. Rones, "The Labor Market Problems of Older Workers," *Monthly Labor Review*, May 1983.

Table E-10.—Percentage of Total Money Income by Source, All Persons Aged 65+

Income (1979)	Earnings	SSA	Private pensions	Asset income	Government assistance
<$5,000	3%	76%	3%	6%	12%
$5,000-9,999	10	59	12	15	4
$10,000-14,999	18	43	17	19	3
$15,000-24,999	34	26	16	22	2
$25,000+	48	11	13	27	1

SOURCE: *Retirement Income Opportunities in an Aging America: Income Levels and Adequacy*, Employee Benefit Research Institute, 1982, Table I-20, page 30. Tabulations from 1980 Census.

Table E-11.—Total Income for Families and Unrelated Individuals, by Age, 1982

Income Class	Under 65		65+	
	Percent	Number	Percent	Number
Families:				
<$7,499	11%	5,697,560	14%	1,343,580
$7,500–12,499	10	5,179,600	22	2,111,340
$12,500–17,499	11	5,697,560	18	1,727,460
$17,500–24,499	18	9,323,280	19	1,823,430
$25,000+	50	25,898,000	26	2,501,000
Mean income	$28,585		$20,990	
Total number	51,796,000		9,597,000	
Unrelated individuals:				
<$5,000	21	4,095,420	32	2,689,920
$5,000–5,999	6	1,170,120	14	1,176,840
$6,000–6,399	3	585,060	9	797,000
$7,000–9,999	11	2,145,220	17	1,400,000
$10,000–17,499	28	5,460,560	17	1,408,000
$17,500+	31	6,045,620	11	936,000
Mean income	$14,602		$9,366	
Total number	19,502,000		8,406,000	

SOURCE: Derived from *Current Population Reports*, Series P-60, No. 140, "Money Income and Poverty Status of Families and Persons in the United States: 1982," U.S. Bureau of the Census, table 6, p. 12.

Table E-12.—Work Status of Adults Aged 65+, 1979 (percent)

Work status	Couples			Singles		
	65–69	70–72	73+	65–69	70–72	73+
Full-time	14%	6%	3%	7%	4%	1%
Part-time	26	23	12	21	13	6
No work	60	71	85	72	83	93

SOURCE: T. Borzilleri, *Income and Expenditures of the Elderly*, Contract No. 333-8050, submitted to the Office of Technology Assessment, October 1983.

Table E-13.—Estimated Mean Income of Elderly Persons, by Source of Income, Sex, and Selected Age Groups (1980 Dollars)

Age group	Earnings (1980)	Social Security (1982)	Pensions (1982)
Men:			
62–64	—	$3,949	$2,334
65–71	$8,369	—	—
65–67	—	5,084	1,876
68–71	—	4,972	1,736
72+	7,454	4,138	601
Women:			
62–64	—	2,637	1,141
65–71	7,297	—	—
65–67	—	3,115	846
68–71	—	3,219	771
72+	6,255	3,271	259

SOURCES: Earnings—*The Elderly and the Future Economy*, Lawrence Olson, et al., 1981, table 3-9, p. 52; Social Security and Pensions—S. R. Zedlewski, *Microsimulation of the Private Pension System: Four Projections to the Year 2020*, Urban Institute, January 1983, table 5, p. 25.

Table E-14.—Distribution of Persons Aged 58-63 by Self-Reported Health Status, by Marital Status and Selected Age Groups, 1969

Health status	Total	Men, spouse present				Men, no spouse				Women, no spouse			
		Total	58–59	60–61	62–63	Total	58–59	60–61	62–63	Total	58–59	60–61	62–63
Number (millions):													
Total	6.8	4.2	1.5	1.4	1.3	0.7	0.3	0.2	0.2	2	0.6	0.6	0.7
Percent of above:													
Better than peers	43%	35%	34%	35%	36%	28%	25%	30%	30%	35%	35%	35%	34%
Same as peers	41	42	44	42	41	41	43	40	38	39	41	38	39
Worse than peers	20	19	18	21	19	27	29	25	28	20	20	21	20
Don't know	4	3	3	2	4	4	3	5	4	5	4	5	6

SOURCE: *Retirement History Survey*, 1969.

Table E-15.—Distribution of Persons Aged 58-63 With Work Limitations, by Extent of Limitation, Sex, Marital Status, and Selected Age Groups, 1969

Extent of limitation	Total	Men, spouse present				Men, no spouse				Women, no spouse			
		Total	58–59	60–61	62–63	Total	58–59	60–61	62–63	Total	58–59	60–61	62–63
Number (millions):													
Total	6.8	4.1	1.5	1.4	1.3	0.7	0.2	0.3	0.2	2.0	0.6	0.6	0.7
Percent of above:													
No limitation	61%	63%	67%	62%	58%	53%	59%	54%	47%	61%	65%	60%	58%
Mobility only	4	4	4	4	4	2	2	2	3	3	3	4	3
Work limitation	35	33	29	34	38	44	40	44	50	36	32	36	39

SOURCE: *Retirement History Survey*, 1969.

Table E-16.—Work Limitations by Longest Held Occupation, Persons Aged 58-63, 1969

Longest held occupation	Number reporting (in millions)	Percent with work limitations
Total	4.8	35%
Professional	0.4	21
Farmer	0.4	45
Manager	0.8	28
Clerical	0.2	30
Sales	0.2	31
Craftsman	1.1	33
Operative	1.0	39
Service	0.3	38
Farm laborer	0.1	49
Nonfarm laborer	0.3	43

SOURCE: *Retirement History Survey*, 1969.

Table E-17.—Labor Force Participation Rates, United States, 1900-83 (percent in labor force)

Sex/age	1900	1920	1940	1944	1950	1955	1960	1970	1976	1983
Both sexes:	55.0%	55.8%	55.9%	63.1%	58.3%	58.7%	57.4%	60.3%	61.2%	63.8%
Men:										
14+	87.7	85.9	83.9	89.8	84.4	83.6	79.7	79.2	76.9	—
14–17	—	—	—	—	—	34.4	46.7	48.4	—	—
18–19	63.6	52.6	44.2	70.0	53.2	49.5	73.1	68.8	72.1	65.4
20–24	91.7	91.0	96.1	98.5	89.0	90.8	88.9	85.1	85.2	82.9
25–34	—	98.1	99.0	96.2	97.7	96.4	92.9	94.2	94.2	—
35–44	96.3	97.2	98.5	99.0	97.6	98.4	96.4	95.7	94.6	95.4
45–54	—	95.5	97.1	95.8	96.4	94.3	92.9	90.6	90.8	—
55–64	93.3	93.8	87.2	92.1	87.0	88.3	85.2	81.5	73.5	69.7
65+	68.3	60.1	45.0	52.2	45.8	40.6	32.2	25.8	19.4	16.5
Women:										
14+	20.4	24.1	28.2	36.8	33.1	34.8	36.1	42.8	46.8	—
14–17	—	—	—	—	—	20.8	34.6	40.6	—	—
18–19	26.8	28.4	23.3	42.0	31.5	29.9	51.0	53.4	58.9	58.4
20–24	32.1	38.1	49.5	55.0	46.1	46.0	46.1	57.5	65.0	69.0
25–34	—	35.2	39.0	34.0	34.9	35.8	44.8	56.9	69.7	—
35–44	18.1	22.4	28.8	40.5	39.1	41.6	43.1	50.9	57.6	69.6
45–54	14.1	17.1	24.3	35.8	38.0	43.8	49.3	54.0	54.6	62.3
55–64	—	18.7	25.4	27.0	32.5	36.7	42.5	40.7	42.1	—
65+	9.1	8.0	7.4	9.8	9.7	10.6	10.5	9.2	7.8	7.9

SOURCES: Adapted from *Aging and Society. Volume 1: An Inventory of Research Findings*, by M. W. Riley and A. Foner, Russell Sage Foundation, 1968. Data for 1970, 1976, and 1983 are from *Employment and Earnings*, Bureau of Labor Statistics, January 1984.

Table E-18.—Average Monthly Retired Worker Benefits With and Without Reduction for Early Retirement, 1961-80

At end of year	Without reduction for early retirement		With reduction for early retirement	
	Men	Women	Men	Women
1961	$84	$65	$69	$57
1962	85	66	71	58
1963	87	67	72	58
1964	88	69	73	59
1965	96	75	79	64
1966	97	76	80	65
1967	99	78	82	66
1968	115	92	95	78
1969	118	95	97	79
1970	139	112	115	94
1971	156	126	130	105
1972	192	156	161	130
1973	197	164	164	135
1974	224	186	187	154
1975	247	206	207	169
1976	270	224	226	183
1977	293	242	246	198
1978	320	264	268	214
1980	380	288	349	275

SOURCES: Adapted from Bixby, 1976, p. 6, and *Social Security Bulletin*, September 1979, p. 82. From Foner and Schwab, 1981, p. 48. 1980: *Social Security Bulletin, Annual Statistical Supplement*, 1982.

Table E-19.—Retirees' Answers to Hypothetical Job Offers, by Year of Retirement (percent)

	1976 retirees		1978 retirees
	1976	1978	1978
Definitely accept	3%	6%	5%
Maybe accept	14	11	20
No, health problems	40	40	33
No, other reasons	43	43	42

SOURCE: T. Borzilleri, *Income and Expenditures of the Elderly*, Contract No. 333-8050, submitted to the Office of Technology Assessment, October 1983.

Table E-20.—Retirees' Attitudes[a] Towards Their Retirement, 1980-83

Reponse to question	Average 1980–83	1980	1981	1982	1983
Glad I retired	62%	60%	61%	64%	63%
Rather still be working	32	30	33	32	33
Undecided	6	10	6	4	4

[a] Note: Response is to question: "Are you glad you retired or would you rather still be working?"

SOURCE: Derived from *AARP Annual Survey of the Opinions of Older Americans*, AARP, Washington DC, 1980, 1981, 1982, 1983.

Table E-21.—Retirement Satisfaction, by Income, 1983

Income class	<$4,000	$4,000–$6,999	$8,000–17,999	$18,000+
Glad retired	35%	52%	69%	81%
Rather still be working	65	46	27	14

SOURCE: *AARP 4th Annual Survey of the Opinions of Older Americans*, AARP, Washington, DC, July 1983.

Table E-22.—Reported Reason[a] for Not Working, 1980-83 (percent)

	Average 1980–83	1980	1981	1982	1983
Don't want or need to	31.3%	32%	27%	34%	32%
Too old	21.8	17	19	24	27
Health	25.8	24	33	23	23
No work available	4.0	2	4	5	5
Rules (retirement test)	2.3	2	3	2	2
Don't know/other	13.8	23	14	12	6

[a] Note: Response is to question: "Is there any particular reason why you are not currently working?"

SOURCE: *AARP 4th Annual Survey of Opinions of Older Americans*, AARP, Washington, DC, July 1983.

Table E-23.—Number and Rate of Labor Force Participation, by Age, Sex and Race, 1990 and 1995 (numbers in millions)

	1990		1995	
	Number	LFPR[a] (in percent)	Number	LFPR (in percent)
***Both sexes and races*:**				
45–54	19.9	78.8%	24.9	80.0%
55–64	11.0	52.7	10.9	9.5
65+	3.2	10.5	3.1	9.5
***Men*:**				
White:				
45–54	9.9	92.3	12.2	92.1
55–64	5.8	66.3	5.7	65.5
65+	1.7	15.3	1.6	13.7
Black and other races:				
45–54	1.2	84.1	1.6	84.2
55–64	0.6	58.9	0.7	57.4
65+	0.1	12.0	0.1	9.9
***Women*:**				
White:				
45–54	7.5	67.1	9.5	69.7
55–64	4.0	41.2	4.0	42.2
65+	1.2	7.4	1.1	6.9
Black and other races:				
45–54	1.2	66.6	1.6	68.4
55–64	0.6	43.6	0.7	43.7
65+	0.2	8.2	0.2	7.7

[a] Labor force participation rate

SOURCE: Bureau of Labor Statistics, unpublished data.

Table E-24.—Number and Rate of Labor Force Participation, by Age, Race and Sex, 1995: Middle-Growth Trend Projections

	Labor force participation			
	Number (in millions)		Rate (in percent)	
	White	Black and other	White	Black and other
***Men*:**				
16–24	9.3	1.3	79.1%	52.7%
25–34	15.3	2.8	94.6	86.0
35–44	16.7	2.7	96.2	90.5
45–54	12.2	16.2	92.1	84.2
55–64	5.7	0.6	65.5	57.4
65+	1.6	0.1	13.7	9.9
***Women*:**				
16–24	9.0	1.5	75.4	55.3
25–34	13.4	2.9	81.8	81.1
35–44	14.5	2.9	82.7	83.1
45–54	9.5	1.6	69.7	68.4
55–64	4.0	0.7	42.2	43.7
65+	1.2	0.2	6.9	7.7

SOURCE: Bureau of Labor Statistics, unpublished data.

Table E-25.—Labor Force Participation Rates by Age, Race and Sex, 1995

	1995
Both:	
65+	9.5%
65–69	17.9
70–74	10.3
75+	3.6
Men:	
White:	
65+	13.7
65–69	21.8
70–74	14.1
75+	6.6
Black and other races:	
65+	9.9
65–69	15.6
70–74	11.0
75+	4.0
Women:	
White:	
65+	6.9
65–69	14.7
70–74	7.3
75+	2.1
Black and other races:	
65+	7.7
65–69	18.8
70–74	4.9
75+	1.6

SOURCE: Bureau of Labor Statistics, unpublished data.

Table E-26.—Labor Force Participation Rates, by Selected Age Groups, 1995 and 2020 (in percent)

	1995		2020	
16–24	16%		16%	
25–34	26		24	
35–44	28		23	
45–54	19	29.3	20	37.5
55–64	8		14.3	
65+	2.3		3.2	

SOURCE: Bureau of Labor Statistics, unpublished data.

Table E-27.—Actual and Projected Employment by Industry, Selected Years, 1982-95 (numbers in millions)

Industry	1982 (actual)	1990 (projected)	1995 (projected)
Agriculture	2.8	2.7	2.6
Mining	0.7	0.8	0.9
Construction	5.5	7.0	7.9
Manufacturing	11.3	13.6	14.5
Durable goods	7.9	8.7	9.0
Transportation	3.1	3.5	3.6
Communications	1.4	1.7	2.0
Public utilities	1.0	1.1	1.1
Trade	22.5	26.3	28.5
Finance/insurance/real estate	5.9	7.1	7.7
Services	24.3	29.3	32.6
Government	1.5	1.6	1.7

SOURCE: V. A. Personick, "The Job Outlook Through 1995: Industry Output and Employment Projections," *Monthly Labor Review*, November 1983.

Table E-28.—Projected Employment Changes for Selected Industries, 1982-95

Industry	Average annual rate of change		
	1982-95	1982-89	1990-95
Fastest growing:			
Medical and dental instruments	4.3%	3.2%	6.1%
Business services	3.9	4.1	3.6
Iron and ores mining	3.9	5.7	1.1
Computers and peripheral equipment	3.8	4.0	3.4
Audio and T.V. broadcasting	3.8	4.2	4.0
Other medical services	3.8	3.6	4.0
Plastics products	3.5	4.1	2.4
Scientific and control instruments	3.4	3.2	3.7
Electronic components	3.2	3.6	2.7
New construction	3.1	3.3	2.8
Most rapidly declining:			
Leather tanning and industry	-3.3	-2.3	-4.9
Dairy products	-2.3	-2.1	-2.6
Wooden containers	-2.3	-2.3	-2.2
Leather products	-2.2	-2.4	-1.9
Tobacco manufacturers	-2.1	-1.2	-3.4
Bakery products	-2.0	-1.0	-3.7
Rail transport	-1.6	-1.8	-1.2
Cotton	-1.5	-1.5	-1.5
Private households	-1.5	-1.8	-0.8
Dairy and poultry products	-1.3	-1.4	-1.3

SOURCE: V. A. Personick, "The Job Outlook Through 1995: Industry Output and Employment Projections," *Monthly Labor Review*, November 1983.

Table E-29.—Projections of the Twenty Fastest Growing Occupations, Percent Increase: 1982-95

Occupation	Percent growth in employment
Computer service technicians	96.8%
Legal assistants	94.3
Computer systems analysts	85.3
Computer programmers	76.9
Computer operators	75.8
Office machine repairers	71.7
Physical therapy assistants	67.8
Electrical engineers	65.3
Civil engineering technicians	63.9
Peripheral EDP equipment operators	63.5
Insurance clerks, medical	62.2
Electrical and electronic technicians	60.7
Occupational therapists	59.8
Surveyor helpers	58.6
Credit clerks, banking and insurance	54.1
Physical therapists	53.6
Employment interviewers	52.5
Mechanical engineers	51.5
Mechanical engineering technicians	51.6
Compression and injection molding machine operators	50.3

SOURCE: G. T. Silvestri, J. M. Lukasiewicz, and E. M. Einstein, "Occupational Employment Projections Through 1995," *Monthly Labor Review*, November 1983.

Table E-30.—Projections of the Forty Occupations With Largest Growth, 1982-95

Occupation	Change in total employment (thousands)	Percent of growth in total employment	Percent increase in occupation
Building custodians	779	3.0%	27.5%
Cashiers	744	2.9	47.4
Secretaries	719	2.8	29.5
General clerks, office	696	2.7	29.6
Salesclerks	685	2.7	23.5
Nurses, professional	642	2.5	48.9
Waiters and waitresses	562	2.2	33.8
Teachers, kindergarten and elem	511	2.0	37.4
Truckdrivers	425	1.7	26.5
Nursing aides and orderlies	423	1.7	34.8
Sales representatives, technical	386	1.5	29.3
Accountants and auditors	344	1.3	40.2
Auto mechanics	324	1.3	38.3
Supervisors of blue-collar workers	319	1.2	26.6
Kitchen helpers	305	1.2	35.9
Guards and doorkeepers	300	1.2	47.3
Food prep and fast food workers	297	1.2	36.7
Managers, store	292	1.1	30.1
Carpenters	247	1.0	28.6
Electrical and electronic engineers	222	0.9	60.7
Licensed practical nurses	220	0.9	37.1
Computer systems analysts	217	0.8	85.3
Electrical engineers	209	0.8	65.3
Computer programmers	205	0.8	76.9
Maintenance repairers, utility	193	0.8	27.8
Helpers, trade	190	0.7	31.2
Receptionists	189	0.7	48.8
Electricians	173	0.7	31.8
Physicians	163	0.7	34.0
Clerical supervisors	162	0.6	34.6
Computer operators	160	0.6	75.8
Sales reps, nontechnical	160	0.6	27.4
Lawyers	159	0.6	34.3
Stock clerks	156	0.6	18.8
Typists	155	0.6	15.7
Delivery and route workers	153	0.6	19.2
Bookeepers, hand	152	0.6	15.9
Cooks, restaurants	149	0.6	42.3
Bank tellers	142	0.6	30.0
Cooks, fast food	141	0.6	32.2

SOURCE: G. T. Silvestri, J. M. Lukasicwicz, and M. E. Einstein, "Occupational Employment Projections Through 1995," *Monthly Labor Review*, November 1983.

Table E-31.—Projections of the Twenty Most Rapidly Declining Occupations, 1982-95

Occupation	Percent decline in employment
Railroad conductors	32.0%
Aircraft structure assemblers	21.0
Central telephone operators	20.0
Taxi drivers	18.9
Postal clerks	17.9
Private household workers	16.9
Child care workers	16.9
Maids and servants	16.7
Farm laborers	15.9
College and university faculty	15.0
Roustabouts	14.4
Postmasters and mail superintendents	13.8
Rotary drill operators and helpers	11.6
Graduate assistants	11.2
Data entry operators	10.6
Stenographers	7.4
Farm owners and tenants	7.3
Typesetters and compositors	7.3
Butchers and meat cutters	6.3
Farm supervisors	3.7

SOURCE: G. T. Silvestri, J. M. Lukasiewicz, and M. E. Einstein, "Occupational Employment Projections Through 1995," *Monthly Labor Review*, November 1983.

Table E-32.—Distribution of Employment by Occupational Group, 1982 and Projected 1995 (percent)

Occupational group	1982	1995
Professional, technical, and related	16.3%	17.1%
Managers, officials and proprietors	9.4	9.6
Salesworkers	6.9	6.9
Clerical workers	18.8	18.9
Craft and related workers	11.4	11.6
Operatives	12.8	12.1
Service workers	16.0	16.3
Laborers except farm	5.8	5.5
Farmers and farmworkers	2.7	1.9

SOURCE: G. T. Silvestri, J. M. Lukasiewicz, and M. E. Einstein, "Occupational Employment Projections Through 1995," *Monthly Labor Review*, November 1983.

Table E-33.—Estimated and Projected Mean Income, Selected Years: 1980-2050

Age group	1980	1990	2050
Men:			
65–71	$8,369	$9,078	$10,094
72+	7,454	8,101	9,042
All 65+	7,850	8,537	9,517
Women:			
65–71	7,297	7,989	8,998
72+	6,255	6,885	8,528
All 65+	6,658	7,303	8,703
Families:			
65–71	18,019	19,925	22,270
72+	14,984	16,675	18,874
All 65+	16,608	18,452	20,746

SOURCE: L. Olsen, C. Caton, and M. Duffy, *The Elderly and the Future Economy*, 1981, table 3-9, p. 52.

Table E-34.—Current and Projected Distribution of Elderly With Incomes Below Adequate Budget Levels, by Selected Age Groups, 1979-2005

	1979	1990	2005
Individuals:			
Men:			
65–71	45%	42%	36%
72+	50	47	39
Women:			
65–71	50	46	39
72+	59	52	38
All individuals:	54	49	38
Families:			
Head 65–71	29	24	19
Head 72+	41	36	28
All families:	34	29	23

SOURCE: L. Olsen, C. Caton, and M. Duffy, *The Elderly and the Future Economy*, 1981, table 3-9, p. 52.

Table E-35.—Projected Mean Income (1980 dollars), by Source, Sex, and Selected Age Groups, 1982-2020

	Social Security			Private pensions		
	1982	2000	2020	1982	2000	2020
Men:						
62–64	$3,949	$5,791	$8,061	$2,334	$3,703	$4,974
65–67	5,084	5,573	7,865	1,876	3,509	4,521
68–71	4,972	5,526	7,831	1,736	2,834	4,518
72+	4,138	4,589	6,571	601	1,419	2,586
Women:						
62–64	2,637	3,233	4,674	1,141	1,603	1,865
65–67	3,115	3,452	4,804	846	1,584	1,897
68–71	3,219	3,362	4,992	771	1,103	1,776
72+	3,271	3,558	4,594	259	586	1,047

SOURCE: S. R. Zedlewski, *Microsimulation of the Private Pension System: Four Projections to the Year 2020*, Urban Institute, January 1983, table 5, p. 25.

Table E-36.—Distribution of Elderly Persons With Private Pensions, 1982 Estimates, and Projections for 2000 and 2020, by Sex

	Men			Women		
	1982	2000	2020	1982	2000	2020
62-64	25%	53%	62%	9%	23%	39%
65-67	31	54	65	11	24	41
68-71	34	55	66	12	23	42
72+	25	43	63	9	16	31

SOURCE: S. R. Zedlewski, *Microsimulation of the Private Pension System: Four Projections to the Year 2020,* Urban Institute, January 1983, table 6 p. 27.

Table E-37.—Projected Future Annual Family Income at Age 65 (1982 Dollars)

Age in 1979	Year of retirement	Married couples	Non-marrieds
25-34	2013-2023	$34,088	$15,697
35-44	2003-2013	29,709	14,921
45-54	1993-2003	22,469	9,846
55-64	1983-1993	17,347	7,127

SOURCE: S. J. Schieber, *Social Security: Perspectives on Saving the System,* Employee Benefit Research Institute, 1982, table 111-17, p. 100.

Table E-38.—Percent of Workers Not in the Labor Force, by Years of Education, 1969

Years of education	Number reporting (in thousands)	Percent not in the labor force
Total	4,823	17%
0-8	2,106	21
9-11	891	17
12	1,031	11
13 or more	795	12

SOURCE: *Retirement History Survey,* 1969.

Table E-39.—Comparison of Surveys on Work Force Disability, 1969-80

	Percent without disability			Percent with work limitations			Percent unable to work			Percent limited in activity		
Survey	45-54	55-64	65+	45-54	55-64	65+	45-54	55-64	65+	45-54	55-64	65+
RHS, 1969[a]	61%	—	—	35%	—	—	13%	—	—	—	22%	—
Lando, et al., 1978[b]	76	63	—	6	6	—	11	25	—	7	6	—
NCHS, 1978-79[c]	81	71	55	—	—	—	4	9	17	10	15	22
NCHS, 1978-80[d]	77	—	56	—	—	—	—	—	—	18		38

[a] Retirement History Survey, 1969 (ages 58-63 only).
[b] Lando, Cutler, and Gambler, 1978.
[c] National Center for Health Statistics, 1978-79.
[d] National Center for Health Statistics, 1978-80 (whites only).

SOURCE: OTA, adapted from sources noted above.

Table E-40.—Proportion of Older Workers Within Occupations, by Selected Age Group, 1982 (in percent)

	45+	55+	65+
Professional	28%	11%	2%
Managerial	39	17	3
Sales	32	17	5
Clerical	27	11	2
Craft	35	13	2
Operatives	30	12	1
Transportation	29	13	2
Nonfarm laborer	21	9	2
Private household	41	27	11
Service	28	15	4
Farm	56	37	14

SOURCE: Bureau of Labor Statistics, unpublished data.

Table E-41.—Distribution of Older Workers by Occupation, by Sex and Selected Age Groups, 1982 (in percent)

	Men		Women	
	45-64	65+	45-64	65+
Professional	17%	15%	15%	12%
Managerial	19	18	9	9
Sales	16	10	7	12
Clerical	6	6	33	25
Crafts	21	12	2	1
Operatives	8	5	11	7
Transportation	5	3	<1	<1
Nonfarm laborers	5	6	<1	1
Private household	<1	<1	3	10
Service	8	13	17	21
Farm	3	12	<1	1

SOURCE: Bureau of Labor Statistics, unpublished data.

Appendix F

Glossary of Terms and Acronyms

Glossary of Terms

Accessory apartment: A separate apartment created within a single-family residence that results in little or no change in the house's external appearance.

Activities of daily living (ADL): Basic self-care activities, including eating, bathing, dressing, transferring from bed to chair, bowel and bladder control, and independent ambulation, which are widely used as a basis for assessing individual functional status.

Acute care: Medical care designed to treat or cure disease or injury, usually within in a limited time period. Acute care usually refers to physician and/or hospital services whose duration is less than 3 months.

Acute condition: An illness or disorder which is characterized by a sudden onset, sharp rise, and short course.

Adult day care: Social and health services provided for physically or mentally impaired individuals in a nonresidential, day-care setting.

Age-adjusted rate: An indicator of the actual change in demographic rates over time that controls for the effects of age-structure differences in the population by weighting the age-specific rates according to the age distribution of the population in a given, earlier, reference year.

Age-specific rate: The rate of occurrence of an event (e.g., death, marriage, birth, illness) for a specified age group in a population.

Aged: Persons aged 65 and over.

Aging: The gradual changes in the structure of any organism that occur with the passage of time, that do not result from disease or other gross accidents, and that eventually lead to the increased probability of death as the individual grows older. This process is associated with genetic and biological factors, environmental influences, and, for humans, socioeconomic status.

Aging of the population: The increasing proportion in the total population of older (65 and over) relative to younger (less than 65) persons. It is generally measured in percentage distribution by age group, but also measured in median age, the age at which 50 percent of the population is older and 50 percent is younger.

Alzheimer disease: The most common form of dementia, an organic brain disease leading to progressive loss of brain function and eventual death. The cause is unknown and there is no effective standard medical treatment.

Appropriate technology: Technology that is developed or adapted in response to the needs, desires, and capabilites of impaired people.

Arteriosclerosis: A group of diseases characterized by the thickening and loss of elasticity in the arterial walls of either the brain or the heart.

Arthritis: Inflammation of the joints due to infectious, metabolic, or constitutional causes.

Assessment technology: Testing instruments or procedures to measure and evaluate the physical, mental, and social functioning of individuals.

Assistive device: A tool, prosthesis, or gadget that helps the individual to compensate for certain functional impairments, such as hearing or vision loss, or difficulty walking or eating.

Atherosclerosis: An extremely common form of arteriosclerosis in which deposits of yellowish plaques containing cholesterol and lipoid materials are formed within the walls of large and medium-sized arteries.

Board and care homes: Nonmedical facilities that provide room and board and some degree of protective supervision on a 24-hour basis. Examples include adult foster homes, group homes, larger residential care facilities, and retirement homes.

Cancer: A malignant tumor of potentially unlimited growth that expands locally by invasion and systematically by metastasis (transfer from one site to another).

Capitation: A uniform payment or fee for service.

Cardiovascular disease: Heart disease; resulting from debilitation of the heart and blood vessels.

Cerebrovascular disease: Stroke; resulting from debilitation of the blood vessels of the cerebrum, or brain.

Channeling demonstration program: The National Long-Term Care Demonstration Program, funded by the U.S. Department of Health and Human Services (DHHS) and the Administration on Aging (AoA), designed to test the efficacy of case management in controlling costs and improving access to appropriate long-term care.

Chronic condition: A physical or mental illness or disorder characterized by a long duration (usually more than three months) or frequent recurrence.

Cohort: A population group that shares a common property, characteristic, or event, such as a year of birth or year of marriage. The most common cohort is the *birth cohort,* a group of individuals born within a defined time period, usually a calendar year or a 5-year interval.

Cohort component method: A system which separately projects age- and sex-specific fertility, mortality, and net migration rates for each 1-year or 5-year birth cohort, using a base population derived from the most recent census. Projections often include three alternative levels of each demographic component.

Cohort data: Information relevant to particular population groups that are defined by birth or other historical events or dates and which are used to indicate change over time.

Cohort effects: The consequences of the particular set of historical events that a cohort experiences over time.

Congregate housing: A group-living environment that provides an onsite meal program and may provide other social, medical, and recreational services. Residents have private apartments within the housing facility.

Crude rate: The number of "events" (e.g., births, deaths) occurring within a total population, often expressed as number per 1,000 population.

Deafness: A degree of hearing impairment that renders hearing nonfunctional for ordinary purposes.

Dementia: The loss of intellectual mental function, due to many different acute and chronic diseases, including Alzheimer disease, which may affect the white matter and blood supply of the cerebrum.

Diabetes mellitus: A familial constitutional disorder of carbohydrate metabolism that is characterized by inadequate secretion or utilization of insulin, by excessive amounts of sugar in the blood and urine, and by thirst, hunger, and loss of weight.

Diagnosis-related groups (DRGs): A classification system that groups patients according to diagnosis, type of treatment, age, and other relevant criteria. In October 1983, Medicare instituted a prospective reimbursement system based on 467 DRGs. Under this system, hospitals are paid a set fee for treating patients in a single DRG category, regardless of the actual cost of care for the individual.

Disability: The inability to perfom an activity in the manner or in the range considered normal because of physical or mental impairment.

Diuretics: Agents (e.g., drugs) that tend to increase the secretion and flow of urine.

Echo (elder cottage housing opportunity) housing unit: A compact, efficiently designed, temporary structure that are erected in backyards of family homes and designed for use by elderly relatives. Also referred to as *granny flat.*

Elderly household: Any household that is maintained (or "headed") by a person aged 65 or older.

Elderly population: All persons aged 65 and over. In designated cases in this report the age identifier can be as low as 40 years (e.g., "older worker" in the ADEA) or as high as 85 years (the very old).

Electronic cottage: A computer-based office at home that may provide opportunities for older workers who want to work on a part-time or flex-time basis and/or avoid travel to work.

Environmental fit (environmental congruence): The extent to which the physical, social, and psychological milieu responds to the needs of the individual. In many cases, environmental "demands" can be alleviated by changes in one or more elements of the environment, thereby providing improved environmental fit or congruence.

Fertility: The number of live births occurring to women of child-bearing age (usually expressed as "the annual number of births per 1,000 women aged 15 to 44").

Functional dependence: The inability to attend to one's own needs, including the basic activities of daily living. Dependence may result from the changes that accompany natural aging, or from a disease or related pathological condition.

Functional impairment: Inability to perform basic self-care functions such as eating, dressing, and bathing, or instrumental home management activities such as cooking, shopping, or cleaning because of a physical, mental, or emotional condition.

Geriatric assessment center: An agency that provides multidisciplinary evaluations of physical, mental, emotional, and social problems of elderly patients and recommends appropriate action.

Handicap: A disadvantage resulting from a physical or mental impairment or disability that limits or prevents the fulfillment of a role that is normal (for that individual) in a given environment.

Hard technology: Tangible products of research and development efforts, such as machines, robots, appliances, drugs, and physical aids.

Hearing impairment: A deficit in hearing acuity, including both partial and total hearing loss.

High technology: Complex products of research and development efforts, including items such as sophisticated new medical instruments, surgical procedures, or computerized robotic manufacturing systems.

Home care: Medical, social, and supportive services provided in the home, usually intended to maintain independent functioning and avoid institutionalization.

Hospice: A method of care that provides supportive medical and social services for terminally ill individuals and their families. Hospice services can be provided in a hospital, nursing home, congregate center, or the patient's home.

Household: A social unit comprised of those living together in the same dwelling, whether they are related to each other or not (sometimes distinguished as single-person households or family and nonfamily households).

Housing tenure: House ownership or rental status.

Hypertension: In the elderly, defined as blood pressure greater than 140/90 mmHg, or isolated systolic blood pressure greater than 160 with normal diastolic blood pressure.

Impairment: A physical or mental abnormality that can be readily identified or diagnosed.

Incidence: The estimated number of new cases of a given illness or condition appearing within a specified time period (which in this report is generally one year), within a defined population group.

Information technology: The application of computers and telecommunication systems to the creation, storage, manipulation, and dissemination of information.

Instrumental activities of daily living (IADL): Home management and independent living activities, such as cooking, cleaning, using a telephone, shopping, doing laundry, and managing money.

Joint debridement: Removal of unwanted tissue from the joint space.

Life care/continuing care communties: Communities that provide a continuum of services for elderly residents, including homes or apartments for independent living, home care services, infirmary, and, sometimes, nursing home services. Payment of an initial membership or entrance fee and a monthly fee guarantees the individual most types of long-term care services for the rest of his life.

Life expectancy: A measure of the average remaining years of life at specified ages for different subgroups (e.g., by sex and race) of a population.

Life span: The biological upper age limit that a human can potentially reach, currently considered to be about 115 years.

Long-term care: A variety of health and social services provided for individuals who need assistance because of physical or mental disability. Services can be provided in an institution, the home, or the community, and include *informal services* provided by family or friends as well as *formal services* provided by professionals or agencies.

Low technology: Simple products of research and development efforts, such as in-home assistive devices and gadgets.

Medicaid: A Federal/State program, authorized by Title XIX of the Social Security Act, to provide medical care for low income individuals. Federal regulations specify mandated services, but States can determine optional services and eligibility standards. The Federal Government's share of costs ranges from 50 to 78 percent and is based on per capita income in the State.

Medical technologies: Drugs, devices, and medical and surgical procedures used in medical care, and the organizational and support systems within which they are produced and provided.

Medicare: A federally funded health insurance program authorized by Title XVIII of the Social Security Act to pay for medical care for eligible elderly and disabled beneficiaries. Medicare reimburses part of the costs for acute care and some types of long-term care. Beneficiaries pay an annual deductible and co-payments for most covered services. The program is divided into two sections: Part A, which covers hospital and inpatient physicians' services, and an optional Part B, which covers some outpatient physicians' services.

Medigap insurance: Insurance policies offered by private companies designed to cover part of the cost of the Medicare deductibles, co-payments, and some medical services that are not reimbursable by Medicare.

Morbidity: The relative incidence or prevalence of disease, generally expressed in rates for specific populations in a specified period of time.

Mortality: The number or proportion of deaths in a given population within a specified period of time.

Myocardial infarction: A heart attack that is generated by a blood clot.

Neoplasm: See *cancer*.

Nursing home: A long-term care facility that provides 24-hour care, skilled nursing care, and personal care on an inpatient basis.

Nutrition: The sum of processes by which an organism takes in, breaks down, and utilizes food substances.

Obesity: Body weight that exceeds by 20 percent or more the amounts specified in standardized tables according to sex, age, and height.

Old old: Persons aged 75 to 84.

Osteoarthritis: A degenerative joint disease occurring chiefly in older persons, accompanied by pain and stiffness. Also known as "osteoarthrosis" and "hypertrophic arthritis."

Osteoporosis: Porous bone; a condition in which total bone mass is decreased while bone volume is unchanged, therefore decreasing the overall density of the bone. Osteoporosis is estimated to cause two-thirds of hip fractures in older people.

Osteotomy: A surgical reshaping of the bone to reduce stress, or to provide a more favorable anatomic orientation of the joint.

Period data: Information about variables or events that characterize a population during a specified short period of time, usually 1 year.

Pharmacokinetics: The study of the bodily absorption, distribution, metabolism, and excretion of drugs.

Population pyramid: A graphic representation of the sex and age composition of a population, using either 1- or 5-year age intervals for each sex to age 85 and over. The pyramid is expressed in numbers or proportions of persons in each subgroup.

Postmarketing surveillance: Monitoring of actual drug use to help identify unknown, adverse reactions, in order to establish drug safety and efficacy.

Presbycusis: Age-associated hearing loss caused by changes in the inner ear.

Premarket testing: Experimentation to determine the safety, toxicity, dosage range, and efficacy of drugs prior to marketing.

Prevalence: The estimated or enumerated number of events (e.g., deaths or persons with a disease) existing in a defined population during a specified period of time (in this report, generally 1 year).

Prevention and preventive strategies: Application of a technology or modification of a behavior pattern that is intended to avert or delay the occurrence of an unwanted or disabling condition.

Prospective payment system: A hospital payment method in which rates are set prior to the period during which they apply and in which the hospital incurs at least some financial risk; rates are based on diagnosis-related groups (DRGs).

Randomized clinical trial: A study of different clinical treatments in which individuals are randomly assigned to test or to control groups.

Recommended Dietary Allowance (RDA): Estimates of the minimum levels of specific nutrients needed to maintain normal function; they may be specified for subpopulations defined by age, sex, height, and weight.

Rehabilitation: Social or medical care designed to restore patients to their former capacity or to a condition of health or independent activity.

Respite care: Physical care and supervision provided for an ill or disabled individual in order to temporarily relieve the primary caregiver from such responsibility.

Risk factors: Characteristics, behaviors, substances, or environmental and other factors that are statistically associated with an increased likelihood of developing a given condition.

Social/health maintenance organization (S/HMO): A provider of a wide range of health and social services for a prepaid annual premium.

Soft technology: A process or organizational system, such as research and the development of new knowledge, which can lead to the development of hard technology.

Supplemental Security Income (SSI): A Federal program enacted in 1972 to provide monthly cash payments to aged, disabled, and blind individuals who have incomes below the minimum levels established for these subpopulations.

Technology: The development of knowledge and/or its application to solving practical tasks and problems. Technology can refer to such factors as biomedical research into the causes of arthritic conditions as well as wheelchairs used by persons suffering from severe arthritis. Technology can be described as "soft" (research and knowledge), or "hard" (products of research), and "high" (complex) or "low" (simple).

Terminal illness: A life-threatening illness or advanced stage of a serious condition for which there is no hope of survival.

Third-party payers: A method of financing health care, in which an individual purchases insurance from a private (nongovernmental) third party, which in turn will reimburse the individual's health care provider, usually on a per-service basis.

Title III of the Older Americans Act: Federal legislation that provides funding to States for development and coordination of services for the elderly. The Administration on Aging allocates Title III funds to States primarily on the basis of the proportion of each State's population aged 60 and over.

Title XX of the Social Security Act: Federal legislation that provides funding to States for social services for individuals of all ages. Title XX was restructured as a block grant in 1981 and Federal requirements for eligibility and services were eliminated.

Urinary incontinence: Inability to control urinary function.

Very old: Persons aged 85 and over.

Vitality: Ability to remain functionally independent, or to be minimally dependent on various types of assistance.

Young old: Persons aged 65 to 74.

Glossary of Acronyms

AAA — Area Agency on Aging
AARP — American Association of Retired Persons
AAT — alpha-1 antitrypsin
ACS — American Cancer Society
ADA — American Dietetic Association
ADAMHA — Alcohol, Drug Abuse, and Mental Health Administration
ADEA — Age Discrimination in Employment Act
ADL — activities of daily living (functional status scale)
AHA — American Heart Association
AHS — American Housing Survey (formerly, Annual Housing Survey)
AMA — American Medical Association
ANDs — Administratively Necessary Days
AoA — Administration on Aging (USDHHS)
AT&T — American Telephone and Telegraph Co.
BLS — Bureau of Labor Statistics
BSE — breast self examination
CAT — computerized axial tomography
CBO — Congressional Budget Office
CDA — Committee on Dietary Allowances of the Food and Nutrition Board
CDBG — Community Development Block Grants
CHD — coronary heart disease
CPI — Consumer Price Index
CPR — *Current Population Reports* (U.S. Bureau of the Census)
CRS — Congressional Research Service
CWA — Communications Workers of America
DHHS — U.S. Department of Health and Human Services
DNA — deoxyribonucleic acid
DOL — Department of Labor
DRGs — diagnosis-related groups
DRI — Data Resources Inc.
EEOC — Equal Employment Opportunity Commission
FDA — Food and Drug Administration
FmHA — Farmers Home Administration
FSP — Food Stamp Program
FTC — Federal Trade Commission
GAO — U.S. General Accounting Office
GI — gastrointestinal
GNP — gross national product
HANES — National Health and Nutrition Examination Survey
HCFA — Health Care Financing Administration (USDHHS)
hCG — human chorionic gonadotropin
HDL — high density lipoproteins
HHA/HRA — health hazard/health risk appraisal
HMO — health maintenance organization
HUD — Housing and Urban Development (U.S. Department of)
IADL — instrumental activities of daily living
ICD — International Classification of Diseases
IND — investigational new drug
IOM — Institute of Medicine (National Academy of Sciences)
IPP — Investment in People Program
JCAH — Joint Commission on Accreditation of Hospitals
JTPA — Joint Training Partnership Act
LDL — low density lipoproteins
LTC — long-term care
MAb — monoclonal antibody
MVSR — *Monthly Vital Statistics Report* (NCHS)
NAS — National Academy of Sciences
NASA — National Aeronautics and Space Administration
NCHS — National Center for Health Statistics
NCPIE — National Council for Patient Information and Education
NHAS — National Hearing Aid Society
NHIS — National Health Interview Survey
NHLBI — National Heart, Lung, and Blood Institute
NIA — National Institute on Aging
NIADDK — National Institute of Arthritis, Diabetes, and Digestive Kidney Diseases
NIH — National Institutes of Health
NIMH — National Institute of Mental Health
NINCDS — National Institute of Neurological and Communicative Diseases and Stroke
NIOSH — National Institute of Occupational Safety and Health
NNHS — National Nursing Home Survey
OARS — Older Americans Resources and Services (assessment instrument)
OMAR — Office for Medical Applications Research
OTA — Office of Technology Assessment
OTC — over-the-counter (drugs)
PBS — Public Broadcasting System
PHS — U.S. Public Health Service
PMS — post-marketing surveillance (generally used for drug testing)
PRO — professional review organization
RDA — Recommended Dietary Allowance
rDNA — recombinant deoxyribonucleic acid
SES — socioeconomic status

S/HMO — social (services) and health maintenance organization
SNF — skilled nursing facility
SSA — Social Security Administration
SSI — Supplemental Security Income
TDD — telecommunication device for the deaf
TEFRA — Tax Equity Financing Reform Act
TPA — tissue plasminogen activator
USDHHS — U.S. Department of Health and Human Services
VA — Veterans Administration

Appendix G

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Consultant on Technology and Aging
Bethesda, MD

American Speech-Language-Hearing Association
Rockville, MD

Index

Index

Abbott Northwestern/Sister Kenny Institute, 165-166
ABLEDATA data base, 213
Acetylcholine, 145n
Activities of daily living (ADL) scale, 290-293
Administration on Aging, 314
Adult day care services, 202-203, 205, 238, 239
Aer Lingus retraining program, 351-352
Age Discrimination in Employment Act (ADEA) of 1978, 36, 336n, 337
Agitation, 224
Alarm systems, 85, 170, 171, 317-318
Alzheimer disease, 62, 63-66, 67-69
  behavior problems, 223, 224
  NIA research role, 102
  prevalence, 193
Alzheimer Disease and Related Disorders Association, 110
American Association of Medical Systems and Informatics, 165
American Association of Retired Persons (AARP), 147, 214
American Cancer Society (ACS)
  dietary recommendations, 126
  Reach for Recovery Program, 163
American Diabetes Association, 124
American Heart Association, 163
American Medical Association, 147
American Telephone & Telegraph Co. (AT&T), 166, 171, 356
Annual Housing Survey (AHS), 282-285, 292
Anti-cholinergic drugs, 145
Anti-diabetic drugs, 148
Anti-inflammatory drugs, 93, 148
Anti-psychotic drugs, 145
Apartments, accessory, 306-307
Apple computer, 165
Appliances, self-monitoring, 317
Appropriate technology, 174n
Architectural Barriers Act, 288
Area Agency on Aging (AAA), 227
Arthritis, 90, 166. *See also* Osteoarthritis
Arthritis Foundation, 89, 92, 94, 110
Arthritis institute at NIH (proposed), 108-109
Artificial sphincters, 75
Asbestos, 356
Aspirin, 92, 146
Assessment measures, 208-210, 235
Assessment technologies, 207-212
Assistive devices
  examples, 212-214, 359-363
  funding, 214-215, 218, 220, 236
  information sources, 213-214, 218, 220, 359-363
  negative attitudes toward, 216
  supply problems, 218-219
  workplace use, 357, 358, 359-363
Audiologists, 86
Audio loop systems, 84
Audiometric testing, 78, 80
Back pain, 166
Baltimore Longitudinal Study on Aging, 100
Bathroom design, 320-323
Bathtub design, 322, 323
Bedpads, 74
Bedroom design, 320
Beth Israel Hospital, 168
Biomedical research
  congressional support, 101-103
  costs, 101-102
  determinants of success, 106-107
  Federal Government role, 100-109
  funding, 103
  issues and options, 110-111
  justifications, 103-105
  resource allocation, 105-109
Biotechnology, 105
Birth cohorts, 36-38
Blacks. *See* Race differences
Board and care facilities, 199-200, 314
Bone cells, 96-97
Bone mass loss. *See* Osteoporosis
Braille devices, 360
Brain, 64
Breast self-examination, 126
Building design and hearing impairment, 86
Bureau of the Census, 38
Bureau of Labor Statistics, 341-344

Calcium intake, 99-100
Canon Communicator Mark II, 362
Cancer
  as cause of death, 48
  risk factors, 125-126
  screening for, 126
Capitation concept, 263
Caregivers
  burnout, 291
  families as, 194-195, 293
  support groups for, 225
  technologies to assist, 195, 220-224
Carpeting, 316
Cartilage tissue, 90-91
Case management, 227
Catheters, 74

Cellular aging, 50
Cerebrovascular disease. *See* Stroke
Chair lifts, 222-223, 316
Cholesterol level, 125
Chronic conditions, 7-10
  age at onset, 50, 51
  community-dwelling elderly, 54, 291-293
  computer-assisted home health care, 169-171
  control of, 50-51
  institutionalization and, 52-53
  policy implications, 51
  prevalence and severity, 54-55, 61, 169, 291-293
  research on. *See* Biomedical research
  self-care, 163-164
  work disability and, 355-356
  See also specific conditions, e.g., Dementia; Hearing impairment
Closed Circuit TV (CCTV) magnification systems, 361
Cochlear implant, 82
Cohort component method, 38
Cohort data, 36-38
Colorectal cancer, 126
Commodore 64 computer, 172
Community Development Block Grants (CDBG), 299-300
Community-dwelling elderly
  chronic conditions, 54-55
  home ownership, 282-283, 301
  urinary incontinence, 70
Community service coordination, 227
Comprehensive Assessment and Referral Evaluation (CARE), 210
CompuServe, 170
Computerized axial tomography (CAT) scanning, 97
Computers
  access to, 171-173
  health programs, 165-169, 176-178
  input and output devices, 162, 172-173, 359-362
  prices, 171-172
  talking, 359
  use by elderly, 160-173, 318-319
  workplace use, 339, 346
Congregate housing facilities
  as type of long-term care, 204
  cost, 206
  design, 312-314
  funding, 239
  privately developed, 310-311
  publicly sponsored, 309-310
  See also Board and care facilities; Nursing homes
Congress
  biomedical research support role, 101-103, 107-109
Congressional Budget Office, 253
Congressional issues and options
  biomedical research, 110-111
  drug testing, education, and labeling, 150-153
  health care services, 270
  housing, 325-327
  information technology, 175-178
  long-term care services, 235-237
  risk factor amelioration, 130-132
  workplace technology, 358-359
Coronary heart disease (CHD)
  as cause of death, 47-48
  risk factors, 122-125

Data Resources, Inc. (DRI), 342
Deafness. *See* Hearing impairment
Death causes
  cancer, 48, 121
  coronary heart disease, 47-48, 121
  stroke, 48, 121
Death rates. *See* Mortality
Degenerative joint disease. *See* Osteoarthritis
Dementia, 8, 62
  causes, 63-64, 66, 68
  clinical changes, 64, 67
  diagnosis, 65, 67-68
  drug-induced, 145
  family impact of, 64, 68
  Federal concern, 65-66
  genetic basis, 65, 68
  life expectancy effect, 64
  prevalence, 64, 67
  research on, 65, 69
Dental care, 256-257
Dental disease, 13, 128
Department of Housing and Urban Development (HUD)
  Annual Housing Survey, 282-285
  housing programs, 295-300
Design Research Center, University of Wisconsin-Stout, 321-322
Diabetes, 124
Diagnosis-related group (DRG) approach, 260, 261-262
Diet. *See* Nutrition
Disability and impairment, 288-289, 355-356
  See also Functional impairment
Disease prevention. *See* Health promotion/disease prevention
Doors
  handles, 323
  thresholds, 316
Dressing aids, 320
Drugs
  as cause of dementia, 63, 66, 145

  as cause of hearing impairment, 83
  as cause of urinary incontinence, 71
  clinical trials, 14-15, 148-149, 152-153
  containers, 144-145
  cost of, 138-140
  development costs, 149
  effects and metabolism, 140
  for treatment of dementia, 65-66
  for treatment of incontinence, 73-74, 75
  for treatment of osteoarthritis, 92-93
  issues and options, 15, 150-153
  over-the-counter, 146
  patient compliance with prescriptions, 143-145
  patient education, 14, 146-147, 151
  side effects and interactions, 141-142
  testing and surveillance, 14-15, 148-149
  use by the elderly, 13-15, 137-147
Dysacusis, 78

Ear, 80
Earnings, 340-341
Elder cottages, 307-309
Elderly households, 23-24, 40, 277-278
  characteristics, 283-285
  homeownership, 282
  housing expenditures, 285-286
Elderly population
  aging of, 41-43
  definition, 3, 35-36
  demographic projections, 3, 38-41
Electrical stimulation, 75
Emergency response alarm systems, 85, 170, 171, 317-318
Employment opportunities
  displacement of workers, 339-341, 344-346
  industry trends, 337-338, 343
  nature of work, 346, 348-349
  occupational trends, 338-339, 343-346
  part-time work, 346-349
  projections, 341-342
  technology-related, 344-364
  See also Labor force; Workplace technology
Environmental fit, 209-210
Environmental press, 289
Estrogen therapy, 98-99
Executive Order 12291, 147
Exercise
  as risk factor, 10-11, 122-123
  bone health and, 99
  osteoarthritis and, 91, 92

Falls, 127, 315-317
Families as caregivers, 194-195, 293
Farmers Home Administration (FmHA) housing programs, 295, 297, 298
Federal Government role
  biomedical research, 100-109
  dementia, 65-66
  health programs, 264-266
  hearing impairment, 88-89
  housing policy, 294-300
  urinary incontinence, 76-77
  See also Congressional issues and options
Federal Trade Commission (FTC), 87
Fertility rates, 4, 38
Fire safety, 317
Floor surfaces, 316, 321
FM amplification devices, 84
Food and Drug Administration (FDA), 75
  drug approval process, 141, 148-149
  health instructional software regulation, 177-178
  hearing aid sale regulation, 87
  Task Group on Computers and Associated Software as Medical Devices, 177
Food assistance programs, 129, 131-132
Forgetfulness, 223-224
Fractures, 12-13, 95, 97-98, 126-127
Functional dependence
  age-specific prevalence, 190-192
  definition, 120
  measurement scales, 290-293
Functional impairment
  causes, 191-194
  chronic disease and, 190
  denial of, 258
  housing and, 288-293
  long-term care funding, 235
  medical diagnosis and, 189-190
  mental condition and, 193-194
  prevalence, 186, 190-191, 290-293
  technologies for caregivers, 222-224
  work disability and, 355-356
Functional independence, 120-121, 133

Gender differences
  hearing impairment, 79-80
  labor force participation, 337, 342
  life expectancy, 45-47, 279-280
  living arrangements, 55, 280-281
  marital status, 278-280
  occupational trends, 338
  osteoporosis, 95, 100
  retirement income, 55
General Accounting Office (GAO), 178, 194
Geriatric Assessment Units, 259
Glucose tolerance as risk factor, 124
Grab bars, 320, 321
Granny flats, 307-309
Grip devices, 362

Handles, 323
Handrails, 316
Health and Nutrition Examination Survey (HANES), 259
Health care
  appropriate for older persons, 257-259
  computer-assisted, 167-171
  self-care, 163-164
Health care costs, 21-23, 101-102, 104-105, 249-257, 268-270
  age-specific, 251-252
  containment strategies, 259-263
  funding of, 251-252
  growth of, 253-256
Health Care Financing Administration (HCFA), 65, 177, 263
Health care industry, 105
Health care providers
  appropriate, 259
  education on drugs, 145-146, 151-152
  house calls, 169, 170
  rehabilitation services, 217-218
  supply of, 169
Health care services
  coordination, 263-266, 270-271
  quality assurance, 270
  research priorities, 269
  utilization, 254-256, 260-261
  See also Health care providers
Health hazard/health risk appraisals (HHA/HRA), 166-167
Health instruction, 164-167, 175-178
Health Interview Survey, 355
Health maintenance organizations (HMOs), 263
Health promotion/disease prevention, 10-13, 119-133
  nutritional deficiencies, 128-129
  research programs, 109
  risk factor amelioration, 121-28
  types of prevention, 120
  workplace technologies, 356-357
Hearing aid dealers, 86-87
Hearing aids, 83-84
  dealers, 86-87
  regulation of sale, 87
Hearing impairment, 9, 62, 78-89
  age at onset, 81-82
  causes, 81
  denial of, 82
  funding for treatment, 87-88
  impact, 82
  prevalence, 78-80
  prevention, 82-83
  service delivery system, 86-87
  technologies to compensate for, 83-86
  treatment, 82-86
  types of, 80-81
Heart disease. *See* Coronary heart disease
Hip fractures, 95
Hip replacement, 93-94, 97-98
Hip surface replacement, 94
Home care
  growth in, 256
  information technology and, 169-171
Home care services, 200-202
  costs, 205
  funding, 237, 238, 239
Home loan programs, 298-299
Homesharing for seniors, 303
Hormone treatments for osteoporosis, 98-99
Hospice care, 203-204, 238, 239
"Hospital on the wrist," 167-168

Hospitals
  cost-containment, 261-262
  long-term care serviçes, 231
  utilization, 264-266, 271
Households, 277-278
  nonfamily, 281
  See also Elderly households
House Select Committee on Aging, 137
Housing, 23-27
  conversions, 304-307
  deficiencies, 283-285, 287
  demographic influences, 277-281
  design and technologies, 315-324
  excess space, 302
  expenditures, 285-287
  functional impairment and, 288-294
  issues and options, 325-327
  maintenance, 301
  modular cottages, 307-309
  ownership, 282-283, 301
  research priorities, 325
  shared, 302-303
  See also Board and care facilities; Congregate housing facilities; Nursing homes
Housing Act of 1937, 294, 295
Housing Act of 1954, 297
Housing Act of 1956, 294
Housing Act of 1959, 296, 297
Housing Act of 1964, 299
Housing and Community Development Act of 1974, 288, 295, 296, 298
Housing and Urban-Rural Recovery Act of 1983, 297
Housing policy, 294-300
Housing legislation
  impact on elderly, 300-301
  summary, 295-300

HUD. *See* Department of Housing and Urban Development
Hypertension as risk factor, 10, 122
Hypertropic arthritis. *See* Osteoarthritis

Immigration rates, 40
Impairment. *See* Functional impairment
Incontinence. *See* Urinary incontinence
Information technology, 15-18
  ability to use, 160-162
  access to, 171-173
  definition, 159n
  drug use monitoring, 142-143
  Federal Government role, 173-174, 175-178
  health care use, 167-171
  health instruction use, 164-167, 175-178
  health program coordination use, 266
  policy formulation, 174-178
  research needs, 174
  self-care use, 163-164
Infrared amplification devices, 84
Institute of Medicine (IOM) NIH organization study, 109
Institutionalization
  functional disability and, 290
  patterns of, 52-53, 281
Insurance coverage for health care, 266-268
International Workshop on Colorectal Cancer, 126
Investment in People Program, California, 354

Japan, 50
Job opportunities. *See* Employment opportunities
Joint Commission on the Accreditation of Hospitals (JCAH), 178
Joint debridement, 94
Joint replacement, 93-94

Kellogg Foundation, 165, 168
Kitchen design, 319-320

Labor force
  displacement, 339-341, 344-346
  industry trends, 337-339
  participation rates, 337-342
  projections, 341-343
Laser cash registers, 348
Life-care communities, 230, 310-311
Lifechec health risk appraisal instrument, 167
Life expectancy, 3, 36, 41, 51
  sex- and race-specific, 42, 43-47, 279-280
"Lifeline" system, 170, 171, 317
Life span, 4, 48-51
Lifting of patients, 222-223
Light pens, 162
Living arrangements
  by age and sex, 280-281
  socioeconomic characteristics and, 55-56
Longitudinal studies
  bone mass loss, 100
  displaced workers, 340, 345
Long-term care, 18-21
  coordination of services, 226-231
  costs, 205-206, 262
  definition, 185
  delivery systems, 225-232, 237
  Federal Government role, 186-187, 235-237
  functional impairment and, 189-194
  funding, 186-189, 235-237, 237-240, 265-266
  need for, 185-186
  planning by individuals, 231-232
  research priorities, 234
  service-related issues, 204-207
  technologies, 187-188, 207-225
  types of services, 194-204

Magnification devices, 361
Malignant neoplasms. *See* Cancer
Marital status, 278-280
Median age of population, 4, 36, 41
Medical Device Amendments of 1976, 178
Medical monitoring, 170
Medical technology, 167-171
  health care cost impact, 253-254
Medicare/Medicaid system, 41
  disbursements, 101
  funding for health devices, 172 (computers)
  funding for hearing services and devices, 87-88
  funding for incontinence products, 77
  long-term care funding, 188-189, 237-239, 264-266
  prospective payment system, 261-262
  reimbursement structure, 129-130, 131, 173, 220-221
  See also Health care costs
Medicaid 2176 Waiver Program, 238-239, 262
Medication. *See* Drugs
Med-Tymer, 144
Men. *See* Gender differences
Meniere's disease, 81, 83
Mental functioning measurement, 209
Mental health programs, 168-169
Mental impairment. *See* Functional impairment
Meridian Health Care, 230-231
Morbidity, 121
Mortality
  age-adjusted, 4n, 6, 43
  age-specific, 38
  disease-specific, 121

  infant, 4, 5
  prediction of, 38
Mortgage insurance programs, 297

National Aeronautics and Space Administration (NASA), 74-75
National Cancer Institute (NCI), 102-103, 107n
National Center for Health Statistics, 355
National Channeling Demonstration Programs, 262
National Commission on Employment Policy, 348
National Council for Patient Information and Education (NCPIE), 146
National Health and Nutrition Examination Survey, 89
National Health Interview Survey, 290
National Hearing Aid Society (NHAS), 86-87
National Heart, Lung, and Blood Institute (NHLBI)
  cholesterol study, 125
  funding, 102-103, 107n
National Homecaring Council, 169
National Housing Act of 1949, 294
National Industrial Recovery Act, 294
National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases (NIADDK), 103
National Institute of Handicapped Research (NIHR), 214, 219
National Institute of Mental Health (NIMH), 65
National Institute of Neurological and Communicative Diseases and Stroke (NINCDS), 65
National Institute on Aging (NIA), 65, 77
  Alzheimer disease research, 102
  biomedical research role, 101-102
  establishment of, 105
  funding, 102
  information system development, 173
  teaching nursing home program, 199
National Institutes of Health (NIH), 93, 98
  biomedical research role, 101-103
  Consensus Conference on osteoporosis, 98, 99, 100
  funding, 101
  organization, 108-109
  worker health study, 355
National Long-Term Care Channeling Demonstration Program, 208, 228
National Nursing Home Survey, 196, 290
National Older Worker Information System, University of Michigan, 348
National Plan for Research on Aging, 102
Networking, 160
Nursing homes
  care systems, 198-199, 220-222
  cost of care, 205
  design, 312-314
  drug use in, 145
  entry age, 52
  funding of care, 188-189, 196, 197, 237, 238, 265-266
  mortgage insurance, 298
  population projections, 52-53, 311
  predictors of residency, 53, 290
  residents, 196-198, 290-291, 311-312
Nutrition
  as risk factor, 12, 124, 125. 126, 128-129
  drug efficacy and, 142
  osteoporosis and, 99-100

Obesity as risk factor, 124, 126
Occupational trends, 338-339, 343-346
Ohio State University, 167
Older Americans Act, 36, 169, 227
  Title III, 239
Older Americans Resources and Services (OARS), 121, 133, 210
Older persons
  biological characteristics, 140
  drug testing and, 148-149, 150
"old-old," 36
On Lok agency, 229
Operation Match, 302
Optacon, 359
Organizational Structure of the National Institutes of Health, 109
Osteoarthritis, 9, 62-63, 89-95
  assistive devices, 92
  biology and anatomy, 90-91
  definition, 90
  diagnosis, 91-92
  prevalence, 89-90
  risk factors, 91
  social factors, 94-95
  treatment, 92-94
Osteoarthrosis. *See* Osteoarthritis
Osteoporosis, 9, 63, 95-100
  as risk factor, 127
  biology and physiology, 96-97
  diagnosis, 97
  prevalence, 95
  prevention, 99-100
  treatment, 97-99
Osteotomy, 94
Otolaryngologists, 86
Ototoxic drugs, 83

Paging devices, tactile, 85
Parnes longitudinal study, 340, 345
Patient Appraisal and Care Evaluation (PACE), 210

Period data, 36-37
Pharmaceuticals. *See* Drugs
Photon absorptiometry
Physical functioning measurement, 208-209
Physical impairment. *See* Functional impairment
Physicians
  cost of services, 263
  See also Health care providers
Picturephone device, 85
Population aging, 36, 40-43
Population pyramids, 45-47
Presbycusis, 81
Prescription records, 168, 319
Preventive measures. *See* Health promotion/disease prevention
Project Match, 303
Public Health Service
  Office of Disease Prevention and Health Promotion, 165, 173
Public housing, 295

Quackery in arthritis treatment, 94

Race differences
  hearing impairment, 80
  housing deficiencies, 284-285
  labor force participation, 342-343
  osteoarthritis, 89
Reading devices, 359, 361
Recommended Dietary Allowances (RDAs), 128, 132
Rehabilitation Act of 1973, 84, 217
  1978 amendments, 288
Rehabilitation after stroke, 125
Rehabilitation, Comprehensive Services, and Developmental Disabilities Amendment of 1978, 218, 220
Rehabilitation Research and Training Centers in Aging, 214, 219
Rehabilitation services
  aural, 85-86
  dissemination initiatives, 219-220
  Federal Government role, 214-215, 236
  funding, 236
  problems limiting use of, 215-218
Rehabilitation technologies. *See* Assistive devices; Rehabilitation services
Rental subsidies, 295-297
Research. *See* Biomedical research
Residential care complexes, 230, 310-311
Respite care, 204
Retirement History Survey, 355
Retirement income, 341
Rhode Island Department of Health, 167
Risk factors, 121-122, 129-130
  cancer, 125-126
  coronary heart disease, 122-125
  dental disease, 128
  fractures, 126-127
  issues and options, 130-132
  sensory loss, 127-128
  stroke, 122-125
Robert Wood Johnson Foundation teaching nursing home program, 199
Robotics International, 345
Robots
  home use, 324, 339
  worker displacement by, 340, 344-345, 347

Safety features, 315-324
Section 8 program, 295-296, 305, 309
Section 202 program, 296-297, 300, 309, 310
Section 236 program, 296
Section 221(d)(3) program, 297
Section 231 program, 297, 305
Section 232 program, 298
Section 312 program, 299
Section 502 program, 298
Section 504 program, 298
Section 515 program, 298
Self-care education, 163-164
Self-help groups, 163-164
Senate Special Committee on Aging, 137
Sensaphone, 318
Sensory loss as risk factor, 127-128
Sex-based differences. *See* Gender differences
Sickness Impact Profile (SIP), 210
Signaling systems, 85, 170, 171, 317-318
Sleeping pills, 141
Small Business Innovation Development Act, 173
Smoking as risk factor, 10, 122, 125
Social changes, 23-27
Social functioning measurement, 209-210
Social/Health Maintenance Organizations (S/HMOs), 229, 263
Social Security Act, 169
  Title XVIII, 237-238
  Title XIX, 238-239
  Title XX, 239
Social Security Administration (SSA) population projections, 38
Sodium fluoride, 98
Speech amplifiers, 362
Speech recognition systems, 85
Splints, 362
Stairs, 292, 316
Stress as risk factor, 11, 123-124

Stroke
  as cause of death, 48
  rehabilitation, 125
  risk factors, 122-125
Suburban elderly, 301-302
Supplemental Security Income (SSI), 239
Surgery for incontinence, 73, 75
Survival curves, 49

Talking machines, 359-360, 361
Tax Equity Financing Reform Act (TEFRA), 256
Technology
  applications, 34
  definition, 7, 137n
  forms of, 33
  See also Appropriate technology; Assessment technologies; Biotechnology; Housing, design and technologies; Workplace technology
Telecommunications devices, 318-319
Telecommunications devices for the deaf (TDDs), 361-362
Telecommunications for the Disabled Act of 1982, 85
Telephone use, 84-85, 362
Teletex system, 85
Teletypewriters (TTYs), 85
Tinnitus, 81
Tissue sensitivity, 141
Toilet design, 320-321, 322
Touch-sensitive terminals, 162
Training procedures for incontinence, 74, 75-76
Training programs. *See* Worker training and retraining programs
Truck devices, 362-363
Tub chairs, 320

Undergarments, 74
Unemployment, 340-341
United Auto Workers Union, 349
Urinary incontinence, 8, 62, 66, 70, 77-78
  causes, 70-71
  costs of, 76-78
  definition, 70
  devices to control, 73, 74-75
  prevalence, 70
  treatment, 72-76
  types, 71-72

Versabraille, 360
Vertebral fractures, 95
"very old," 36
Veterans Administration (VA)
  listening device program, 89
  long-term care services, 229, 240
  rehabilitation services, 214-215, 219
Viewdata system, 85
Viewscan, 361
Vistaphone device, 85
Vitamin D, 98
Voice-activated systems, 162

Walkers, 316
Wandering, 224
White House Conference on Aging, 185, 300
Whites. *See* Race differences
Women. *See* Gender differences
Worker training and retraining programs
  attitudes toward, 352-353
  benefits, 350, 354
  costs, 350-351
  examples, 353-354
  methods, 351-352, 364
  older worker participation, 349-350, 352-353
Workplace technology
  employment opportunities and, 335-349
  health and, 355-357
  issues and options, 358-359
  research needed, 357-358
Work-related changes, 27-29
World Health Organization, 120
Wrist fractures, 95
Wrist injuries, 356

"young-old," 36

zinc deficiency, 99

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